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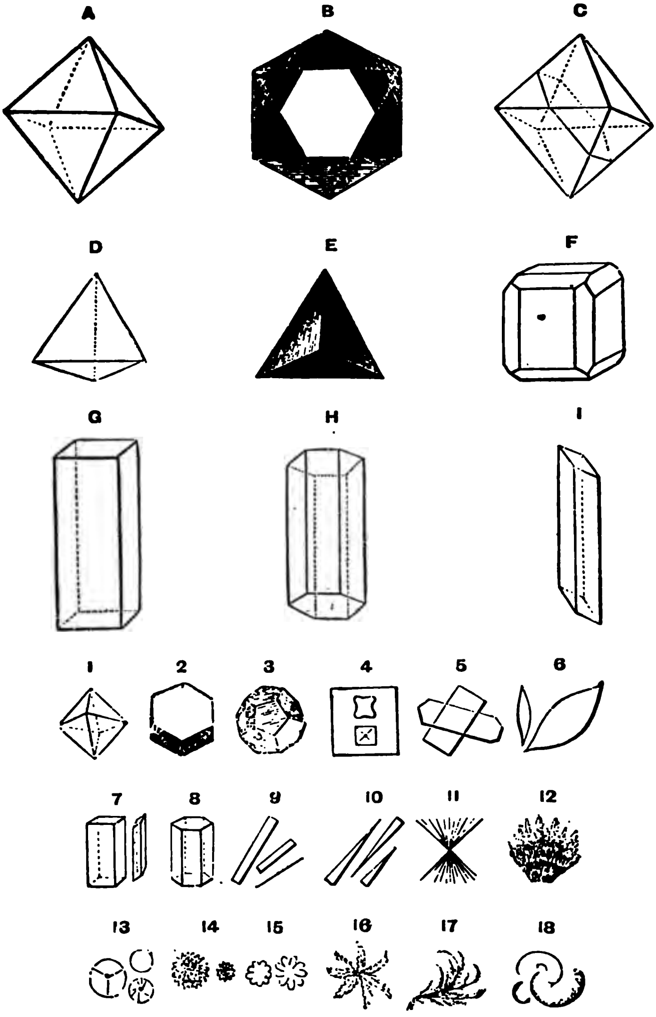

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CRYSTAL FORMS, &c.

EXPLANATION OF PLATE.

A. Regular octahedron in outline.

B. The same as A as it appears when a glass model of it is seen with a triangular facette in advance.

C. The same as A, when cleft by a plane parallel to two of its sides. (The octahedron is the typical form of arsenious acid.)

D, E, F. Tetrahedra observed in some deposits from solutions of tartar emetic.

G. Rectangular four-sided prisms of strychnina.

H. Six-sided prisms of morphina.

I. Right rectangular prisms of oxalic acid and of sulphate of zinc.

1, 2, 3. Forms seen in deposits from solution of strychnina in benzole.

4, 9. Reaction of strychnina with bichromate of potassium or with perchloride of platinum.

5. Reaction of brucina with sulphocyanide of potassium and with perchloride of mercury.

6. Rapid reaction of brucina with ferricyanide of potassium.

7. Flattened prisms belonging to oxalic acid, and square prisms belonging to strychnina.

8. Hexagonal prisms belonging to morphina.

9. Long rectangular plates formed by the instantaneous reaction of sulphocyanide of potassium with strychnina, and of tannic acid with morphina.

10. Reaction of strychnina and spirituous solution of iodine in sulphuric acid.

11. Group of needles occurring in company with 5 and 6 in the reaction of brucina with ferricyanide of potassium. These are also seen in reactions of strychnina with iodo-iodide of potassium and of morphina with hydrochloric acid.

12. Tufts common in deep drops.

13, 14, 15. Various disc forms; 15 often seen in the reaction of strychnina with perchloride of iron.

16. Reaction of brucina with nitroprusside of sodium.

17, 18. Reaction of strychnina with terchloride of gold and with carbazotic acid.

PREFACE.

MANY admirable works upon Forensic Medicine are already in existence, but very few have included Hygiene. This last-named subject, however, is now justly considered of such importance that in the final examinations in medicine the custom is becoming universal of setting (in the Forensic Medicine Paper) at least one question in which sanitary matters are involved.

It has only been possible in the present work to embody the leading facts in connexion with Hygiene, since a lengthened description would have far exceeded the available limits.

The fact that no work has existed, hitherto, of a medium size, and in which the attempt has been made to condense the contents of the well-known large manuals, such as those of Tidy and Woodman, of Guy, of Taylor, and of Casper into a comparatively small, but not too meagre a space, has encouraged me to embark upon the present undertaking and to add yet another contribution to medico-legal literature.

The methods of extraction of the various poisons from the dead body have been specially dealt with, and I have endeavoured as much as possible to explain the more complex chemical processes when such explanation has appeared to me desirable.

In the compilation of the following pages I have been careful to place before the reader the statements and opinions of the most highly esteemed authorities upon Forensic Medicine, and I must express my sincere thanks to my numerous medical friends for many valuable hints during the passage of the various sheets through the press.

An experience of educational matters and of the student world extending over nearly a quarter of a century, has led me to hope that a work such as the present one may prove of some slight service, especially when bearing in mind the favourable reception that has been accorded to my last effort, "The Essentials of Pathology and Morbid Anatomy."

My thanks are due to my publisher, for supplying the many excellent illustrations which the book presents, and also to Messrs. Longmans, who have kindly allowed casts of the botanical plates to be taken from Pereira's "Manual of Materia Medica and Therapeutics."

Lastly, I cannot too strongly impress upon the reader that this volume is not intended to exclude the use of the more elaborate treatises, but is merely to be employed as an introduction to an extremely comprehensive and difficult study, or to serve as a refresher to the memory of the student when upon the eve of his examination.

ARMAND SEMPLE.

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February 1890.

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126. Secale Cornutum (Spurred Rye) Mature Ergot 159
127. Juniperus Sabina (Savin) in Fruit 160
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ESSENTIALS

OF

FORENSIC MEDICINE, TOXICOLOGY,

AND HYGIENE.

FORENSIC MEDICINE, MEDICAL JURISPRUDENCE, or **LEGAL MEDICINE** is the part of medical science in which the connexion between medicine and law is treated. It also deals with cases which are connected with the administration of justice, and with questions that involve the social duties and civil rights of individuals.

TOXICOLOGY is the name applied to the division of forensic medicine in which the nature and detection of poisons are treated, as well as the treatment of the poisoned.

HYGIENE includes the laws affecting the individual and social relations and well-being of man—health and sanitation.

PART I.

FORENSIC MEDICINE.

MEDICAL EVIDENCE.

THE medical man may be summoned as a **common witness**—viz., simply to *state* facts; or as a **skilled** witness or **expert**—to interpret them; he is a skilled witness when he gives an opinion on the facts observed and the views expressed by others, or when he gives his opinion on facts observed by himself. He should maintain a perfectly impartial frame of mind, and should not give any opinion upon the general merits of the case, but simply upon the facts proved on the trial; he should also be careful not to indulge a sentiment of misplaced humanity.

He should reply to questions concisely and clearly, and supply any deficiency if the whole truth is not elicited; never dogmatically assert as facts subjects which are only matters of opinion; and never obtrude opinions when facts only are required; he should employ the plainest and simplest language, avoiding all technical terms, and metaphorical or superlative expressions.

He should refrain from quoting authorities to support his opinion.

On every trial a witness may undergo three examinations. The first is the "**examination-in-chief**" by counsel for the side he appears, then the "**cross-examination**" by the opposing counsel, and the "**re-examination**" by his own side. The first is to elicit his facts and opinions, the second to weaken his statements, the third enables him to explain any apparent discrepancies. He should be careful to avoid the introduction of any new matter, since such a proceeding may render him liable to a further cross-examination. A witness is not allowed to quote authorities, but he may be asked if he agrees with an authority who is esteemed in the profession, and if he answers in the affirmative he becomes an exponent of such an opinion.

Speak of a bruise rather than of a contusion, of a blood-clot than of an apoplectic effusion; give measurements from well-known standards, as an inch, foot, or yard, or a hand or finger's breadth, or compare the size of objects to a shilling or a sixpence, and be most particular with respect to dates.

A professional witness is not bound, either in a civil or criminal case, to give evidence unless paid, but if he is once sworn he cannot refuse to speak as to matters of fact. If subpœnaed at the same time to a civil and criminal case, he must attend first the criminal one; and if the subpœnas are for similar courts, his first attention must be to the superior court. Should the courts be equal in authority, he should obey the summons received first.

NOTES.—These should always be made on the spot and at the time, or as soon as possible after the event to which they relate, and are admissible in a court of law to refresh the memory, not to supply its place. If they are not made at the time, they are inadmissible. If the notes are taken by dictation, they should be immediately examined and corrected.

HEARSAY.—Unless this forms part of the matter before the Court, it is not admissible as evidence. A medical witness cannot cite a case to support his opinion if it consisted partly of statements made by the patient, his attendants, or friends, although he may state in evidence any words he has heard directly referring to the case under investigation.

DEATH-BED CONFESSIONS OR DECLARATIONS.—The law presumes that a dying person will speak the truth, but in order for these statements to be admitted as evidence the person making them must believe that he or she is actually on the point of death, and has absolutely lost all hope of recovery, and so is induced to speak the truth exactly in the same manner as he would when giving evidence on oath. If there is the slightest reason to believe that the declarant entertained any hope whatever, death-bed declarations are inadmissible as evidence. When possible, the declarations should be taken by a magistrate, but, when this officer cannot be obtained, the medical man may write down the statements of the dying person, taking care that they are read to the dying person, and that they are duly signed, if possible, and witnessed.

No leading questions or suggestions must, however, be put to the dying person beyond those which may be required to clear up ambiguity. It is very important that the exact state of the declarant's mind be ascertained, since the person or persons implicated by the declarant's statements are allowed to show that vindictive motives may have influenced the declarant, or that such person's character was not such as to be impressed by a religious sense of his approaching dissolution.

SECRETS.—In a court of justice a medical man may be compelled to divulge secrets which he has obtained during his professional attendance, and which under ordinary circumstances he would not be bound to reveal. This is the law, monstrous as it may seem.

WILLS.—If a medical man should be placed in the position of taking the instructions of a testator, he should write down the wishes in the simplest and fewest words, affixing the exact date and place of the transaction, and at the foot of the document the following words (taking care to leave room for two signatures):—"Signed by the above-named testator, in the presence of us, present at the same time, who have hereunto signed our names as witnesses thereto, in the presence of the said testator, and in presence of each other."

The condition of the testator, both mental and bodily, should be carefully observed, and all the surrounding circumstances well noted while fresh in the memory, as wills thus made are frequently disputed, and the medical man may be submitted to a most searching examination in respect to them.

PERSONAL IDENTITY.

Medical evidence may be required—(1) the living, (2) the dead.

In the Living, questions may turn upon marks on the body, as nævi materni, tattoo-marks, and scars, and with respect to the organs of generation when the sex is in doubt. Tattoo-marks may disappear during life, and vermilion marks sooner than those resulting from Indian ink. The colouring matter has been found in the lymphatic glands after death.

The scars of leech-bites, cupping instruments, and lancet wounds may disappear after a lapse of time, but the scars occasioned by actual loss of substance, or by wounds healed by granulation, never disappear. It is almost impossible to give a positive opinion upon the age of a scar.

The scar (cicatrix) which is the result of a wound depends upon its situation. An elliptical cicatrix is typical of incised wounds: the linear cicatrix is found chiefly between the fingers and toes.

For the purpose of disguise the hair may be dyed black by nitrate of silver or by lead salts. This proceeding may be detected by letting the hair grow, or by dipping some of it in diluted nitric acid and subsequently adding hydrochloric acid or iodide of potassium. The hydrochloric acid will produce a white precipitate with the silver salt, and the iodide of potassium throws down a yellow precipitate with the lead salt.

The hair may be bleached by peroxide of hydrogen or by chlorine, in which case detection may result by allowing the hair to grow, as also by the irregularity of the bleaching and the unnatural feel.

As regards the determination of doubtful sex in the living, attention should be directed to the size of the clitoris or penis, whether perforate or imperforate, the shape of the prepuce, the absence or presence of the testicles and of the nymphæ. Investigations should be made as to discharges (menstrual or vicarious), the general bodily development, the tone of the voice, the growth of hair, and the demeanour of the individual towards either sex.

Openings should be examined carefully with respect to their communications with the uterus or bladder.

In the Dead.—The sex of the skeleton may be shown by the bones in the female being generally smaller and more slender than in the male, the thorax of the female deeper, the costal cartilages

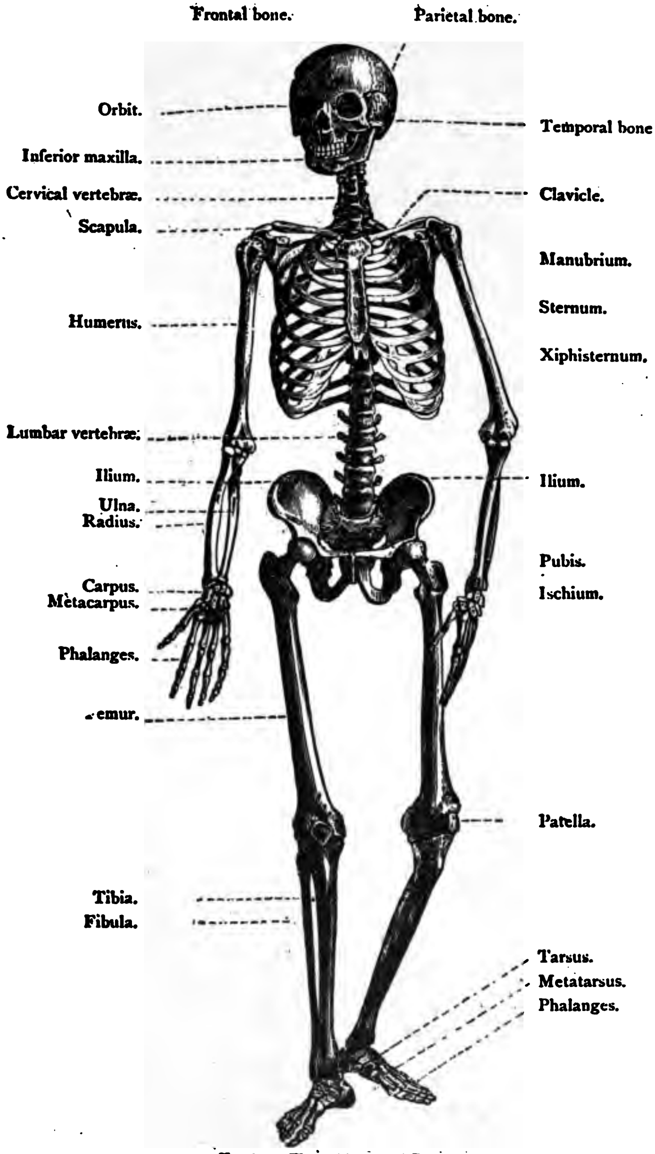
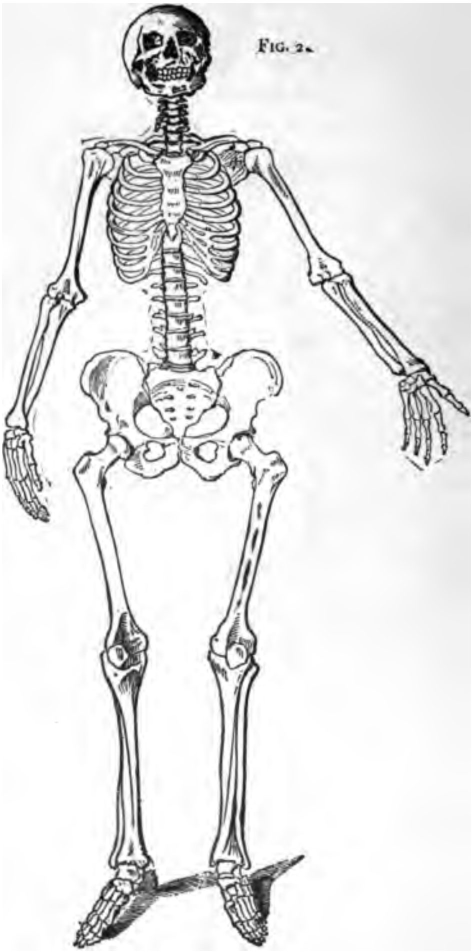


FIG. 1.—THE HUMAN SKELETON.

longer, the sacrum more concave, the ilia more expanded, the coccyx moveable, turned back, the pubes shallow, the tuberosities

FIG. 2.



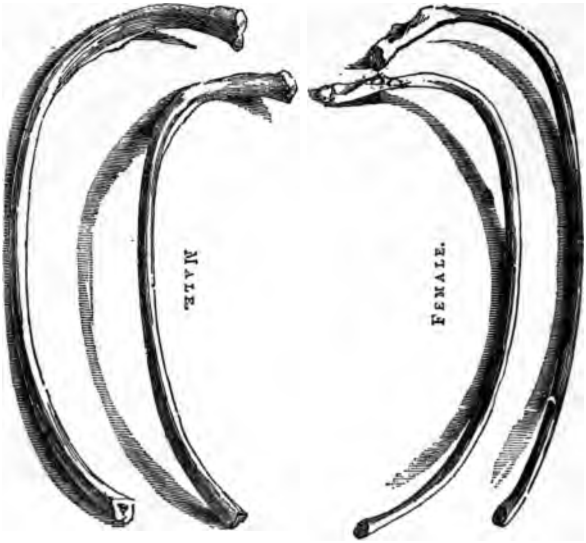
The Female Skeleton, viewed in front.

of the ischia more spread apart, the entire pelvis more shallow and its outlets larger. It must, however, be pointed out that the only really reliable sign is the rounded pubic arch in the female as compared with the pointed arch in the male. Under the age of puberty the examination of the bones throws no light whatever upon the sex of the individual.

Fig. 1 shows a complete skeleton with the names of the various parts of which it is composed; Fig. 2 shows the female skeleton; Fig. 3 male and female ribs, with the difference in their curves; Fig. 4 the male skeleton; Fig. 5 shows the relative situation and proportions of certain parts or segments of the skeleton to each other; Figs. 6 to 12 show the pelvis (outlet and brim) with the various parts of which it is composed.

A calculation of the age may be made from the eruption of the teeth; from the condition of the ribs, of which the cartilages gradually ossify as age advances; from the angle which the ramus of the lower jaw forms with its body (in infancy this is obtuse, in the adult a right angle, and in the aged again obtuse, from the loss of the teeth); from the general state of the epiphyses regarding their attachment to the shafts respectively.

Fig. 3.

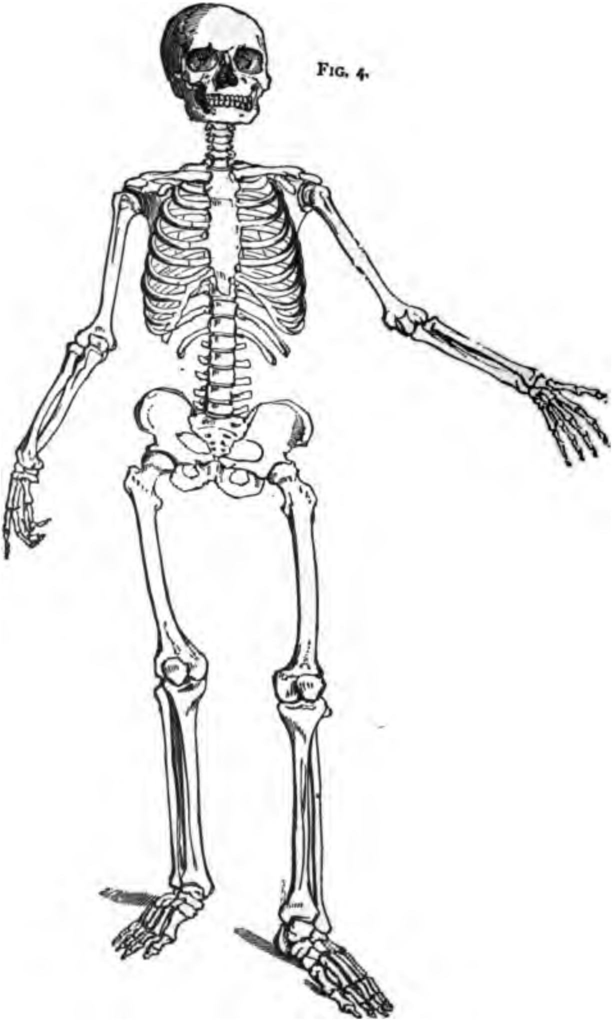


The Male and Female Ribs, showing the difference in their curves.

If the entire skeleton is laid out, and 1½ to 2 inches allowed for the soft parts, a fair estimate of the stature may be made. The respective measurements of the male and female pelvis at the brim are the following :—

	Female.		Male.
The oblique diameter of the pelvis	5 in.	...	4¼ in.
„ transverse	5¼ „	...	4½ „
„ antero-posterior or conjugate	4½ „	...	4 „

FIG. 4.

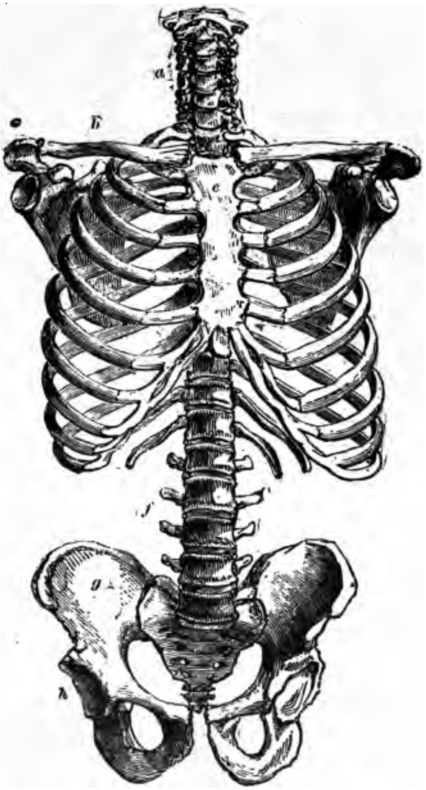


The Male Skeleton, viewed in front.

AGE.

Age in the Living.—The means of determining age in the living adult are very unreliable, but in younger persons, although imperfect, the methods are more precise—viz., the successive appearance of the teeth, both of the first and second dentition.

FIG. 5.



Skeleton of the Torso, or Trunk (front view). *a.* Points to the cervical vertebræ. *b.* Clavicle, or collar-bone. *c.* Acromion process of the scapula. *d.* Ribs, with their cartilages. *e.* The sternum. *f.* Lumbar vertebræ. *g.* Os innominatum of the right side. *h.* Acetabulum. *i.* Obturator foramen. The figure is intended to show the relative situation and proportions of certain parts or segments of the skeleton to each other.

The first set, or the milk teeth, make their appearance in the order following:—

5–7 months	Central incisors.
6–9 "	Lateral incisors.
8–15 "	First molars.
15–18 "	Canine teeth.
18–24 "	Second molars.

These teeth do not appear at the same age in all infants; a few live several years without a visible tooth; some have no teeth until the end of the second year, and others are born with the incisors above the gums.

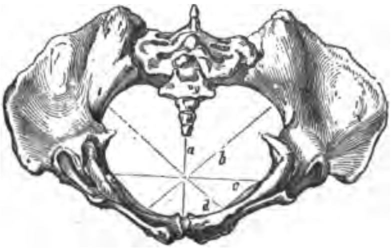
The following table taken from Guy gives the order and probable time of appearance of the permanent set of teeth:—

Age.	Incisors.		Cuspids.	Bicuspids.		Molars.		
Years.	Central.	Lateral.		Anterior.	Posterior.	Anterior.	Second	Posterior.
7	—	—	—	—	—	4		
8	—	—	—	—	—	4		
9	4	4	—	—	—	4		
10	4	4	—	4	—	4		
11	4	4	—	4	4	4		
12 –12½	4	4	4	4	4	4		
12½–14	4	4	4	4	4	4	4	
18 –25	4	4	4	4	4	4	4	4

The permanent teeth are not complete until the arrival of the "wisdoms" (dentes sapientiæ), and this usually occurs from the eighteenth to the twenty-fifth year, and occasionally later.

Age in the Dead.—Calcareous deposits in the arteries and the heart point to the subject having attained to mature if not advanced life.

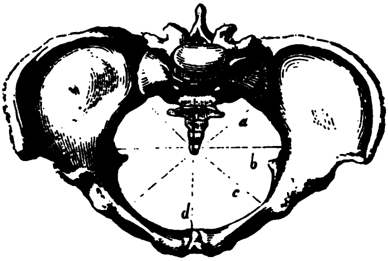
Fig. 6.



Plane of Outlet of the Pelvis. *a.* Antero-posterior diameter. *c.* Transverse. *b. d.* Oblique.

The best guide to the determination of age is afforded by the state of ossification of the bones of the skeleton, of which the following is a summary :—

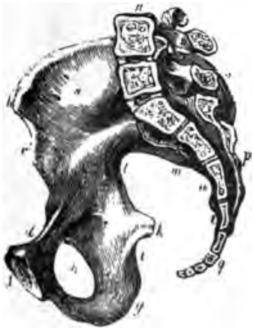
FIG. 7.



Plane of Brim of the Pelvis. *a, c.* Oblique diameter. *b.* Transverse. *d.* Antero-posterior.

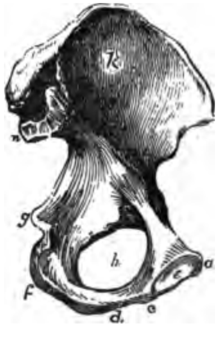
In the **Skull.**—The separate bones generally are all united within a year after birth; occasionally throughout life the two halves of the frontal bone remain separate.

FIG. 8.



Internal view of the os innominatum of the right side with portion of the sacrum attached.

FIG. 9.

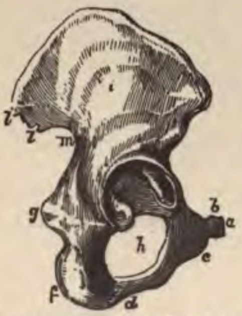


Os Innominatum. *e.* Symphysis pubis. *f.* Ischium. *g.* Spinous process. *f.* Tuberosity. *h.* Obturator foramen. *k.* Inner surface of dorsum ilii. *n.* Ear-shaped surface.

In the **Vertebral Column.**—The arch and body of the vertebræ unite in the *third* year, as do also the body and odontoid process of the axis. About puberty ossification commences in the epiphyses of the spinous and transverse processes, but they are not united to the vertebræ until the age of *twenty-five*, or even later. The several vertebræ of the **sacrum** continue separate until the *age of eighteen,* at which period they begin to unite from below upwards, the process not being completed until *twenty-five* years of age or later. Still later the coccyx becomes united to the sacrum.

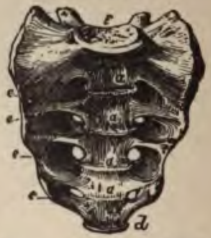
In the **Ribs**.—The epiphyses and shaft continue separate until the age of *twenty-five*.

FIG. 10.



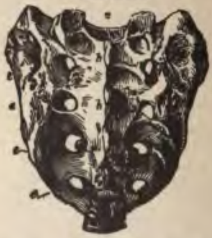
Os innominatum. *a.* Pubis. *b.* Ramus, horizontal. *c.* Ramus, descending. *d.* Ischium, ascending portion. *f.* Tuberosity. *g.* Spinous process. *h.* Obturator foramen. *i.* Dorsum ilii. *l, l.* Spinous processes. *m.* Sciatic notch.

FIG. 11.



Sacrum. (Anterior surface.)

FIG. 12.



Sacrum. (Posterior surface.) *a, a.* Coalesced vertebræ. *c.* Base of pyramid. *d.* Apex of the pyramid. *e, e.* Opening for transmission of sacral nerves.

In the **Sternum**.—The five segments continue separate until puberty, when union takes place in the lower segments.

The body and manubrium do not unite until extreme old age, but the upper segments unite from the *twenty-fifth* to the *thirtieth* year.

In the **Upper Limbs**.—Union takes place in the various centres of the **scapula** from the *twenty-second* to the *twenty-fifth* year.

Of the **clavicle** the sternal epiphysis appears from the *eighteenth* to the *twentieth* year, and becomes joined to the shaft at the age of *twenty-five*.

Of the **humerus**, the head and tuberosity unite at the age of *five* and are joined to the shaft at the age of *twenty*. The condyle unites with the shaft from the *sixteenth* to the *eighteenth* year.

Of the **radius**, the superior epiphysis unites with the shaft at from the *seventeenth* to the *eighteenth* year, and the lower epiphysis unites with the shaft at the age of *twenty*.

With respect to the **ulna** the same holds good.

Of the **metacarpal** and **phalangeal** bones, the epiphyses unite with their shafts at about the *twentieth* year.

In the **Lower Limbs.**—Of the **pubes** and **ischium** the **rami** unite about the *seventh* or *eighth* year; the various parts of which the acetabulum is formed unite from the *sixteenth* to the *seventeenth* year. Complete ossification of the **os innominatum** does not take place until the *twenty-fith* year.

Of the **femur**, the head and shaft unite about the *eighteenth* or *nineteenth* year, the lower epiphysis and shaft continuing separate until the *twentieth* year.

Of the **tibia**, the lower epiphyses and shaft unite in the *eighteenth* or *nineteenth* year. The upper epiphysis unites with the shaft in the *twenty-first* or *twenty-second* year.

Of the **fibula**, the epiphyses and shaft unite somewhat later than those of the tibia.

Of the **metatarsal** bones, the epiphyses and shafts unite from the *eighteenth* to the *twentieth* year; those of the **phalanges** about a year later.

Taking into careful consideration what has been stated above it will be observed that under the age of thirty years, the age may be calculated with some approach to accuracy, but above this age there is greater difficulty, and then the signs of senile degeneration will demand more attention.

In old age the cartilages of the larynx and ribs are liable to become ossified, the former being sometimes completely changed into bone. In consequence of the absorption of the osseous plates of the cancelli, the bones become lighter. The flat bones become thinner, the osseous laminæ approximating. This result is seen in the ilium, scapula, and skull, the sutures of which become either more indistinct or completely obliterated; from the same cause the angle formed by the head of the femur with its shaft becomes diminished. The bones are more brittle, they are of a yellowish colour, and their aspect and touch are greasy, through more or less infiltration of free fat. The bodies of the vertebræ become bevelled off in front, the spine bends forwards, and shrivelling takes place in the intervertebral discs.

The **jaw**, however, is the structure in which age produces the greatest change; in the fœtus and in early infancy the *body* and *ramus* form an exceedingly *obtuse* angle; in middle life. almost a *right* angle; in old age, after the teeth have dropped out, and the alveolar border become absorbed, reversion to the infantile type takes place. The jaw in very old persons presents a highly characteristic appearance.

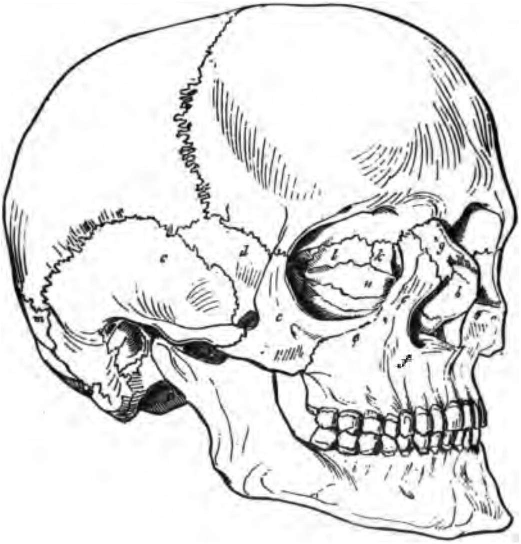
The various bones above mentioned are shown in the drawing of the human skeleton (Fig. 1, p. 5).

Identity of Race is often important, as also is the recognition of a skull being that of a human being as distinguished from a lower animal.

Fig. 13 shows a complete skull with its various parts.

The so-called **facial angle** of Camper (Figs. 14 and 15) is employed to distinguish the cranium of a European from that of the Negro and the ape. In some heads this angle is a right angle, but the facial angle of the European, usually does not exceed 80°; that of the Negro is about 70°, in various kinds of apes (Fig. 16) it varies from 65° to 30°, becoming still more acute in the lower animals, as in the cranium of the wild boar (Fig. 17). Fig. 18 shows the profile of the European, the Negro, and the oran-outan.

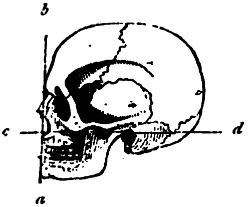
FIG. 13.



The Bones of the Face and Cranium. *a.* Frontal bone. *b.* Parietal bone. *c.* Temporal bone. *d.* Sphenoid bone. *e.* Malar bone. *f.* Superior maxillary. *g.* Nasal bone. *h.* Septum nasi, vertical plate of the ethmoid. *i.* Lower jaw-bone. *k.* Lachrymal bone. *l.* Pars plana of the ethmoid. *m.* Supernumerary bone. *n.* Incisor teeth.

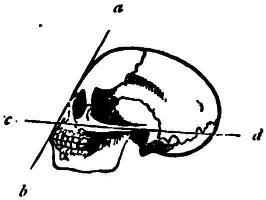
In the Negro the prognathous (projecting) jaws are clearly seen. The Esquimaux' skull is pyramidal in shape. In the Mongolians the malar bones are very prominent. In addition to the characters of the skull, in the Negro the feet are exceedingly wide and flat, and the backward projection of the os calcis is remarkable. Figs. 19 to 22 show the heads of various races. Great caution must, however, be employed in drawing conclusions in regard to race from the bones alone. In the London Hospital Museum may be seen skulls of different races which, although not those of Europeans, might readily be taken for such, both for their size and capacity.

FIG. 14.



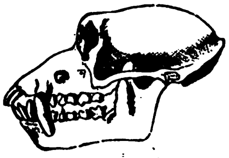
Showing the facial angle of Camper. In European crania usually not exceeding 80°. *a*, *b*, *c*, *d*. Lines forming the facial angle.

FIG. 15.



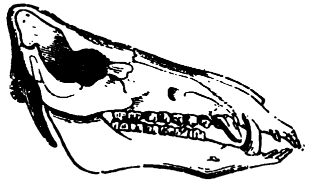
Facial angle of Camper. In the Negro about 70°. *a*, *b*, *c*, *d*. Lines forming the facial angle.

FIG. 16.



Cranium of the Barbary Ape.

FIG. 17.



Cranium of the Wild Boar.

FIG. 18.

Profile of the Negro, European, and Oran Outang.

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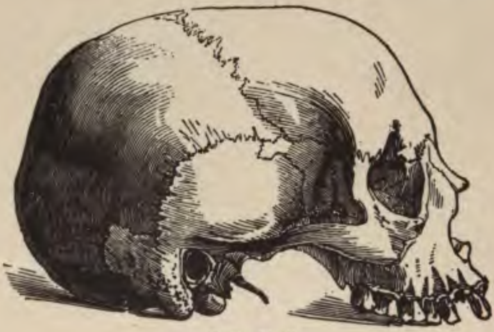
The skin of the Negro and that of other races is peculiar from the depth of colour and thickness of the rete mucosum (stratum Malpighii). Hair is also much modified by race.

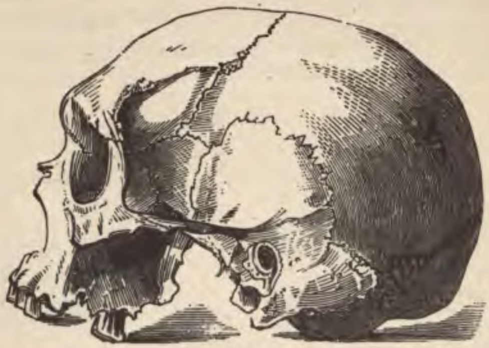
Personal Identity may be deduced from personal peculiarities scars, marks of fracture and dislocation, and loss of limbs. Personal peculiarities may be congenital or acquired. Tricks of manner, handwriting, and the like are often transmitted from father to son, although they occasionally skip a generation (atavism). Moles nævi, and polydactylism (more than the ordinary number of fingers and thumbs), and peculiarities, as hypospadias, may be transmitted through many generations. One eye is—*i.e.*, the iris is—sometimes *of a* different colour to the other. The author was at school with

FIG. 19.



Caffre Skull.

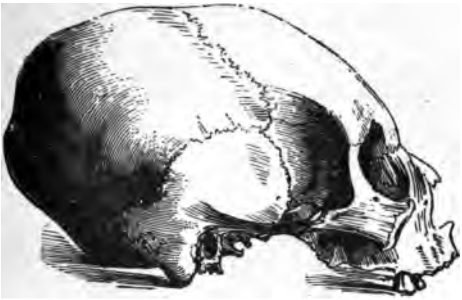
FIG. 20.



Negro Cranium.

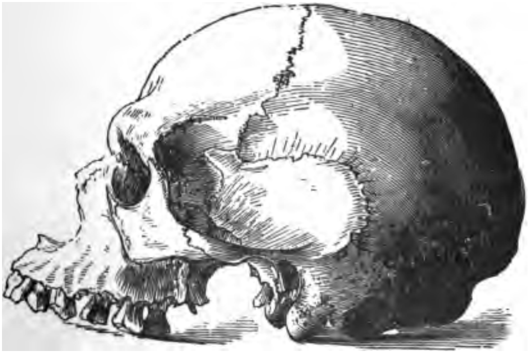
a boy who had one eye blue and the other brown. The loss of one or two fingers has led to the identification of a criminal: and

FIG. 21.



The Cherokee Head.

FIG. 22.



Skull of the Tasmanian.

the presence or absence of teeth, especially artificial ones, has been of great value in determining personal identity.

In the *Tichborne* trial great importance was attached to the following facts:—

1. In the real Roger Tichborne the lobes or lobules of the ears were very badly developed, and continuous with the face. In the Claimant the lobes of the ears were well marked.

2. The real Roger had an issue in one arm, which had been kept open for a long period, and must almost certainly have left an indelible scar or mark.

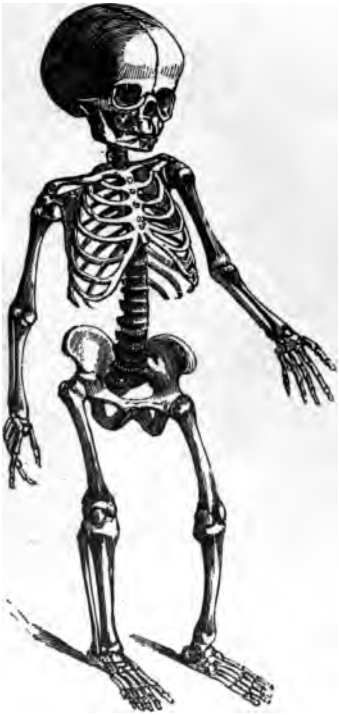
3. The real Roger had also been bled frequently in both arms, in both ankles, and in one temple.

4. There was considerable evidence to the fact of the real Roger having been tattooed.

5. It was asserted by the Claimant or by one of his witnesses that he had a brown mark in his side, but it did not appear that a similar mark was possessed by the real Roger.

The **Infantile Skeleton** presents singular forms and disproportions (Fig. 23). The head presents great bulk as compared to the trunk and limbs, with great disproportion between the cranium and face. The jaws are small, the neck short, the thorax slender and without form; the shoulders are narrow, the spinal column only very slightly curved; the pectoral extremities long as compared with *the lower and with the* torso (trunk) generally. The thigh-bones

FIG. 23.



The Natural Skeleton of a Child about two years old.

are straight and short, and, with the feet and legs, recall the forms of the chimpanzee and oran-outan, the two animals which approach nearest to the structure of man. The skeleton of the feet is elongated and narrow, and the heel-bones project. The limbs are half bent, and are incapable of full extension. The thigh-bones are wide apart at each extremity, or their axis is vertical, resembling the thigh-bones of birds. The pelvis is also peculiar. The ossa innominata are narrow, and their position is almost upright, as in the chimpanzee; the vertebræ of the sacrum are narrow, and resemble those of the lumbar portion of the spinal column; the false pelvis is narrow, as in the quadruped, the antero-posterior diameter of the pelvis being the longest. If these forms remain permanent, the pelvis of the European woman resembles, according to the degree, either that of the Negro or, if more intense, that of the chimpanzee or quadruped, and the natural graceful form never appears.

STERILITY AND IMPOTENCE.

In the **MALE**, the **physical** causes of impotence are: too tender or too great an age, malformation of the genitals, disease or defects in the testicles, constitutional disease or weakness, early and excessive sexual indulgence, abuse of alcoholic stimulants, and masturbation.

Mental causes are aversion, disgust, passion, timidity, and apprehension.

In the **FEMALE**, **sterility** may result from narrowness of the vagina, adhesion of the vulva, absence of the vagina, or tumours of the vagina, and imperforate hymen. The causes in the male above mentioned may entail sterility in the female, as also absence of the ovaries, of the vagina, or great weakness, constant amenorrhœa, menorrhagia, dysmenorrhœa, and salpingitis (inflammation of the Fallopian tubes).

The effects of **castration** in males and the **removal of the ovaries** in females vary very considerably, according as the operation is performed before or after puberty. After emasculation a boy grows fat, his muscles are soft, his appearance and voice feminine, his larynx never enlarging as in the adult male, the growth of the beard is either prevented or hindered, and his character is destitute of manliness. The operation of castration used to be performed in Rome for preserving the soprano voice of the boy, but it has been for many years abandoned. The last of the operatic male soprani was the singer Velluti. In women from whom the ovaries have been removed, sexual appetite is lost, a beard grows, the voice becomes harsh, the breasts waste, the whole appearance is manly, and in general the body is rendered thinner. In fact, the operation actually unsexes the individual.

RAPE.

In English law this crime is defined as "the carnal knowledge of a woman against her will."

The woman must resist to the utmost of her power, although the offence is still rape if she at last succumb through duress or fear. The woman is allowed as a witness, but if her character has been bad her statements may be called in question. The English law makes the carnal knowledge of a child under thirteen years of age a felony and the attempt a misdemeanour; over sixteen the consent of the female does away with the charge of rape. Proof of absolute emission of semen is not necessary to constitute the crime of rape; the mere fact of penetration of the vulva, however slight such penetration may be, establishes the offence.

The **physical signs** of rape in the adult may be rupture of the hymen, laceration of the fourchette, and blood on the parts; in a child, no hæmorrhage may be present, but signs of bruising may appear on the external organs. The patient experiences difficulty in walking, and in passing fæces and urine. In children the signs last longer than in adults. Evidence of a struggle may be shown by the presence of scratches and bruises upon the outraged individual.

Pregnancy may follow rape, and it is possible that a woman accustomed to sexual intercourse may be violated during sleep. A woman may conceive without experiencing the slightest pleasure during the sexual act.

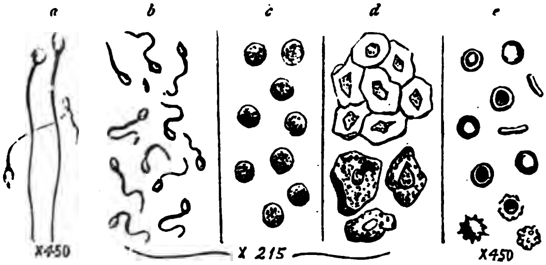
In young and delicate children, and those who are recovering from an attack of scarlatina, a discharge may occur from the vagina, with excoriation of the external genitals, and this occurrence may be taken advantage of to establish a false charge. It must also be remembered that bruising of the soft parts followed by purulent discharge may result from accident. The author has observed one or two cases in which such results have followed from a child sitting down suddenly and forcibly upon a hard, pointed substance, such as the leg of a chair which had been turned over.

There are no means of distinguishing positively between a leucorrhœal and a gonorrhœal discharge.

SEMINAL AND OTHER STAINS.—The garments may be intentionally soiled with blood. There are no means of distinguishing menstrual discharge from blood the result of violence, and grease spots and red juice of fruits on linen have been confounded with blood and seminal stains. Seminal stains are stiff, as if starched; they are of a greyish tint, and when moistened emit the well-known seminal odour. When held near the fire the spots change to a yellow-fawn colour. To determine the seminal nature of a stain, however, the microscope alone affords reliable evidence; although it must be remembered that the semen of a healthy man varies considerably and is very rarely twice alike. *In some cases the semen* may contain no spermatozoa, and thus, if spermatozoa are absent, this is no evidence that the origin of the stain was not seminal.

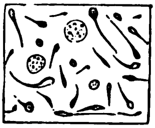
Microscopic Examination of a Seminal Stain.—Appearance of the Spermatozoa or Zoosperms.—Unless remains of the seminal spermatozoa can be detected, it would be highly injudicious to give evidence as to the seminal nature of any stain. The microscopic appearance of the spermatozoa is highly characteristic. These bodies (Fig. 24, *a* and *b*, and Fig. 25) are extremely minute, their whole length frequently not exceeding the $\frac{1}{6000}$th of an inch. The human specimen possesses a flattened, almost oval head, with long and slender filamentous tail. The tail is generally five or six times the length of the head, which is about $\frac{1}{9000}$th of an inch in diameter—roughly speaking, about one-third the size of a human red blood-corpuscle. When alive, the animalcule exhibits a vibratile, undulating movement, which is chiefly executed by the tail. Even when dead the spermatozoa are easily recognised by their shape, and they possess a marvellous power of resisting putrefaction, having been found in putrid semen. Their movements are arrested by weak acids and stimulated by alkalies.

FIG. 24.



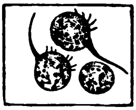
a. Spermatozoa : *e*. Blood-discs (magnified 450 diameters). *b*. Spermatozoa : *c*. Mucous bodies : *d*. Epithelium scales (magnified 215 diameters).

FIG. 25.



Spermatozoa, Zoosperms, seminal animalcules, or Cercaria seminis.

FIG. 26.



Trichomonas vaginæ, showing the large heads, with granules and cilia.

Seminal animalcules have been confounded with minute fragments of linen fibre and granules, and an animalcule has been detected by M. Donné in the vaginal mucus of uncleanly persons called the

Trichomonas Vaginæ.—The differences between the trichomonas vaginæ (Fig. 26) and the seminal animalcule are the following—viz.:

1. The **heads** of the trichomonads are quite three times the size of the heads of the spermatozoa.
2. Internally the trichomonads are **granular**, the heads of the spermatozoa being absolutely structureless and transparent.
3. Several **cilia** are noticeable in the boundary wall of the head of the trichomonad, whereas in the spermatozoa none are present.

Some fungi are said closely to resemble spermatozoa; but in the fungi the apparent tail is far clumsier, light is refracted very differently, and, under favourable circumstances, they may be seen to grow on the glass slide.

PREGNANCY.

The signs of pregnancy are certain and uncertain, or fœtal and maternal.

Among the **uncertain** signs are the following:—Cessation of

FIG. 27.

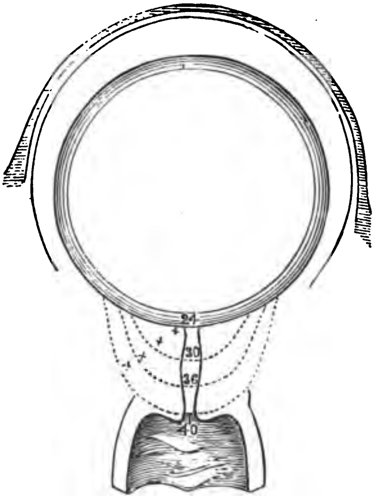
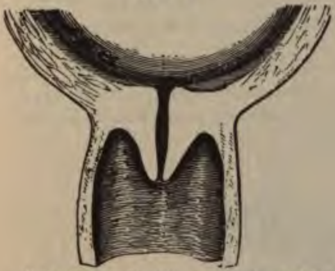


Diagram showing the changes which take place in the shape of the uterus in successive months of pregnancy, and also how the cervix is affected by the growth and expansion of the uterus over its contents. The numbers 24, 30, 36, 40, refer to the several weeks of utero-gestation, the dotted lines *representing the absorption of the cervix by the growth of the uterine contents at these several* months of pregnancy.

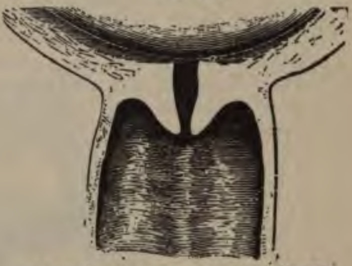
menstruation (this may happen independently of pregnancy), sickness in the morning, salivation, enlargement of the breasts and the

FIG. 28.



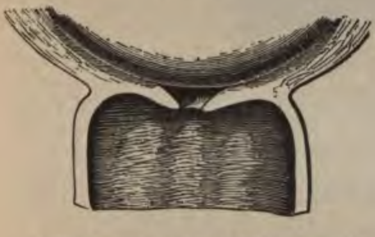
Primipara. Cervix uteri at about sixth month of utero-gestation, showing little or no absorption.

FIG. 29.



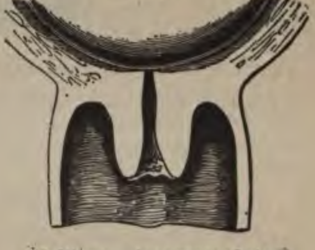
Primipara. Cervix uteri at about six weeks later than Fig. 28, showing evident absorption.

FIG. 30.



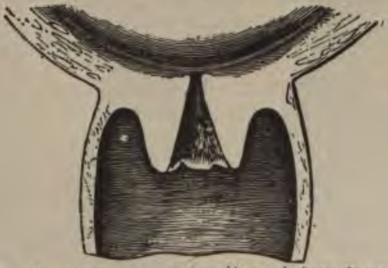
Primipara. Cervix entirely disappeared and expanded over uterine contents.

FIG. 31.



Multipara. Appearance of os and cervix uteri about the sixth month.

FIG. 32.



Multipara. Appearance of os and cervix uteri about six weeks later than at Fig. 31.

abdomen, although these are not always due to pregnancy, and *quickening.*

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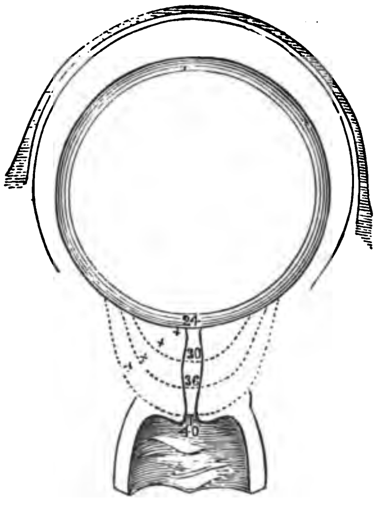

Diagram showing the changes which take place in the shape of the uterus in successive months of pregnancy, and also how the cervix is affected by the growth and expansion of the uterus over its contents. The numbers 24, 30, 36, 40, refer to the several weeks of utero-gestation, the dotted lines representing the absorption of the cervix by the growth of the uterine *contents at these several* months of pregnancy.

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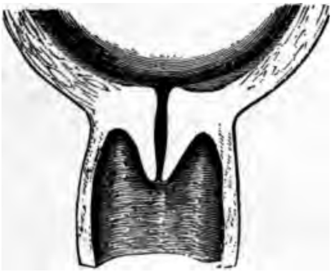
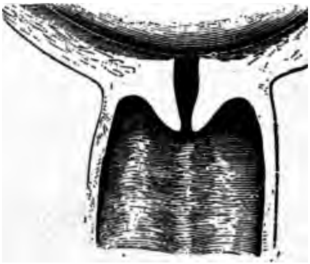


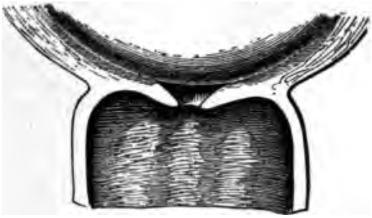
Primipara. Cervix uteri at about sixth month of utero-gestation, showing little or no absorption.

Fig. 29.



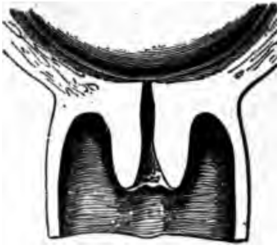
Primipara. Cervix uteri at about
weeks later than Fig. 28, showing evid
absorption.

Fig. 30.



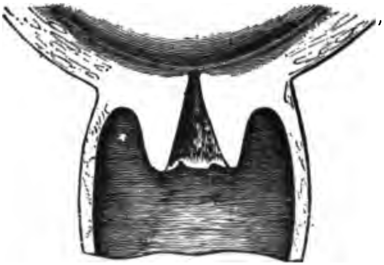
Primipara. Cervix entirely disappeared and expanded over uterine contents.

Fig. 31.



Multipara. Appearance of os an
cervix uteri about the sixth month

Fig. 32.



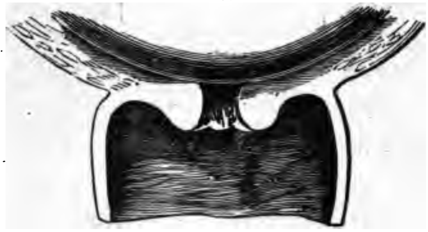
Multipara. Appearance of os and cervix uteri about six weeks later than at Fig. 31.

abdomen, although these are not always due to pregnancy; an
quickening.

The **certain** signs are those which show the presence of the fœtus in utero—viz., the uterine souffle, ballottement, and the pulsation of the fœtal heart, which is about 120 beats per minute; the uterine souffle is synchronous with the pulse of the mother. The discharge of an early ovum, of hydatids, or moles may afford evidence of pregnancy.

Pregnancy may be feigned in order to extort money, or concealed to avoid disgrace, and may also be pleaded by a criminal to stay capital punishment, in which case it is necessary to show that she is *quick with child.*

FIG. 33.



Multipara. Appearance of os and cervix uteri at same period as in Fig. 30.

Figs. 28 to 33 show, in addition to successive changes in the os and cervix in successive periods of pregnancy, the differences in the case of primiparæ and multiparæ at corresponding periods.

DELIVERY.

In **the Living** the signs of recent delivery are the following:—

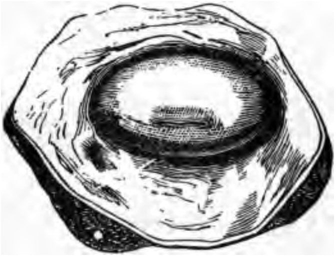
The face is pale, the eyes surrounded by dark circles; there are quickening of the pulse, and a soft warm skin, which is covered with peculiar sweat. Fulness, tenseness, and knotty feeling in the breasts. Distension of the abdomen, with relaxation of its integuments, and light irregular streaks in the lower part of the abdomen. Indications of distension and injury are apparent in the labia and vagina.

During the first three or four days there is a discharge from the uterus of a more or less bloody nature, which in the following few days becomes of a dirty green colour, and a few days later of a yellowish milky and mucous character, continuing for four or five weeks. For the first two or three days the uterus may be felt as a hard, round ball, recovering its normal size in from four to eight weeks after delivery. After the tenth day it is impossible to fix the date of delivery, since at this time most of the signs are absent.

In **the Dead** the signs of delivery are the following:—The external parts present the same appearance as indicated above. The uterus varies in appearance according to the time that has elapsed since delivery. When death has been immediate upon delivery, the uterus is wide open, about 9 or 10 inches in length, and contains clots of blood within it, fragments of decidual membrane lining the interior.

The signs of previous deliveries are sometimes lineæ albicantes (silvery streaks), but these are not reliable, since they may occur from distension the result of other causes. Similar marks may be seen on the breasts. There is a circular, jagged condition of the os uteri; in the virgin state the os uteri (Fig. 34) is smooth and even, without any abrasions, puckerings, or nodulations.

FIG. 34.



Cervix and Os Uteri. The cervix, ovoid. The os, elliptical. In the virgin or nulliparous state, quite smooth and even:

There may be indications of rupture of the perineum or fourchette, absence of vaginal rugæ, and a dark areola round the nipples.

The **CORPORA LUTEA.**—Although the distinction between the true and false corpus luteum is not so marked as to justify an absolute opinion as being previous to pregnancy or otherwise, yet there are certain distinguishing characters.

FIG. 35.

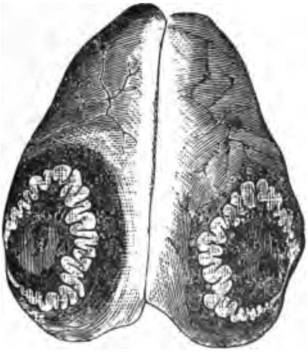
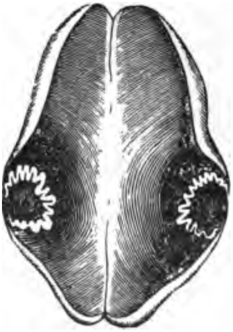


FIG 36.



The name corpus luteum (yellow body) is given to a peculiar cicatrix formed in the Graafian follicle after a ripened ovum has escaped from it, especially when that ovum has been impregnated. The corpus luteum of pregnancy is termed the *true*, and that of the adult virgin ovary the *false*. When conception does not take place the corpus luteum seldom becomes larger than a pea, and usually at the end of six or eight weeks becomes reduced to an insignificant cicatrix. Should, however, impregnation result, the corpus luteum does not retrograde, but continues to increase, and attains the maximum development between the third and sixth month of gestation. It is persistent until delivery, after which event it commences to dwindle, but the characteristic structure may be seen for some months after parturition.

FIG. 37.

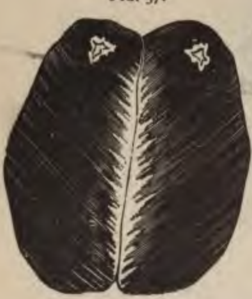


FIG. 38.

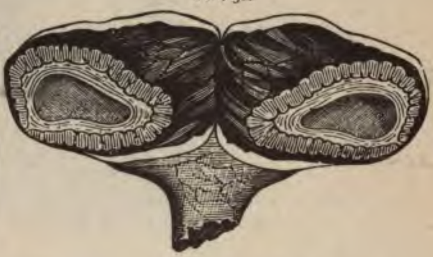


FIG. 39.

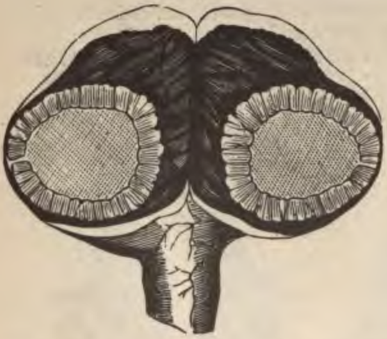
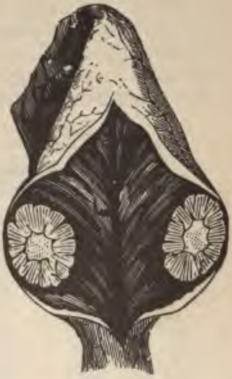


FIG. 40.



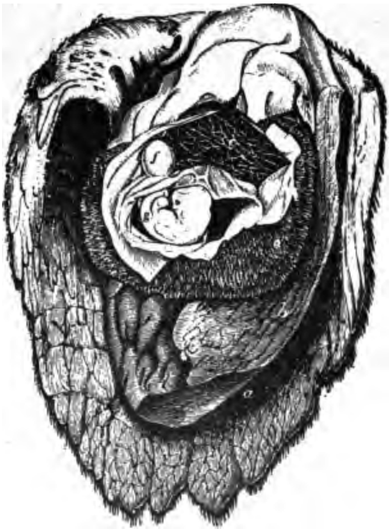
Figs. 35, 36, 37, represent the corpus luteum of menstruation, which declines in a period of two months. Figs. 38, 39, 40, show the corpus luteum of pregnancy, which lasts from nine to ten months, presenting during a good portion of the time a larger size and more solid organisation than that of menstruation.

A medical man must be very careful, when consulted in any case of pregnancy or rape, to obtain the consent of the woman before he proceeds to examine her, as, although her refusal will go against her, he lays himself open to heavy damages if he persists in examining her against her will.

CRIMINAL ABORTION.

This offence consists in giving to any woman, or causing to be taken by her, with the intent to procure her miscarriage, any poison or noxious thing, or using for the same object any instruments or other means whatsoever; also in the use of the same means with the same intent by any woman being with child. Any person or persons so acting are guilty of felony, and the procuring of drugs or instruments for such a purpose is a misdemeanour.

Fig. 41.

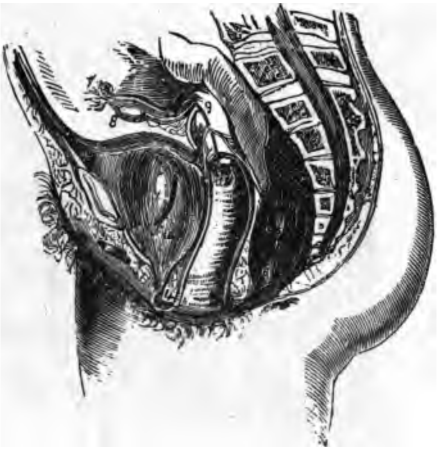


Early Month of Gestation. *a.* Decidua vera, uterine or parietal decidua. *b.* Decidua reflexa of the chorion, or of the ovum. *c.* Primitive placenta. *d.* Inner layer of the chorion. *e.* Outer layer of the chorion. *f.* Umbilical vesicle. *g.* Embryo.

The crime consists in the attempt to, or *intent* to, procure the miscarriage of the woman. Whether she be quick with child or not is immaterial.

Medically, the term **abortion** is applied when the fœtus is expelled before the sixth month; after that period it is called **premature birth.** Legally, however, any expulsion of the contents of the uterus before the full time is called a **miscarriage** or abortion. It is not easy to say, upon an examination of the substance expelled from the uterus, whether abortion has taken place or not. Fig. 41 shows the contents of the uterus in an early month of gestation. The history must be elicited, and careful examination made of the state of the breasts, the hymen, and the os uteri. Abortion may be induced either by the introduction of instruments or attempted by the administration of certain drugs, as ergot, iron, savin, and pennyroyal; but it must be emphatically stated that no medicine is certain to procure abortion unless the woman is strongly predisposed to abort. Any drug given in a dose short of risking the life of the mother would surely fail, and when the drug does accomplish the object it places her life in the greatest peril, and often sacrifices it. Even when the production of abortion is justifiable in certain cases, as when the pelvis is too small to allow of a child being born at full term, the medical man should never act without consulting another practitioner.

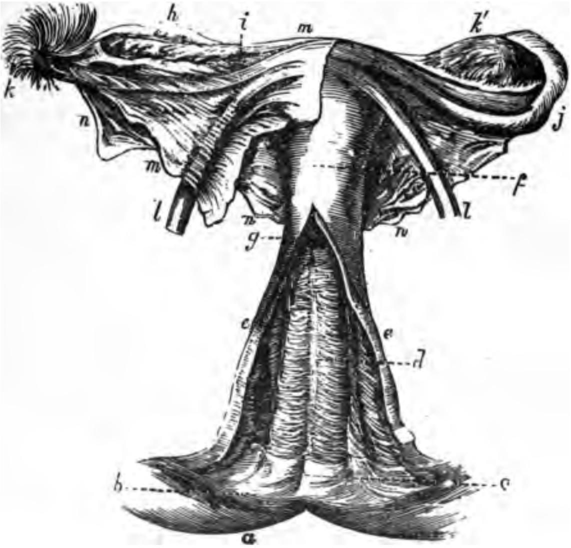
FIG. 42.



Section of Female Pelvis (lateral view of right side). The bladder, vagina, and uterus represented entire. The vagina laid open longitudinally to show the os uteri externum (os tincæ). 1. Urinary bladder. 2. Remains of the urachus. 3. Points to the clitoris. 4. The urethra. 5. Pouch of the rectum where uncovered by peritoneum. 6. Is a short distance above the sphincter. 7. The fimbriated extremity of the right Fallopian tube. 8. The right ovary. 9. The fundus of the uterus. 10. One of the round ligaments. 11. Mucous surface of the vagina, the figure is placed close to the os tincæ.

When death is suspected from the employment of abortives, an examination of the alimentary canal must be made; as to the presence of disease in the internal organs, or to the signs of the action of irritants. If instruments have been used in attempting to induce abortion, post-mortem investigation will most frequently reveal that the neck of the uterus presents numerous minute, more or less irregular wounds, either limited to the uterine walls or penetrating into the organ, their course being marked by infiltration or by the slight extravasation of blood which has coagulated. The exact condition of this extravasation may be of service as indicating the period at which the wound was received. Wounds may extend to the fundus of the uterus, and then in making an autopsy some blunt instrument will glide into the rent by its own weight when passed through the retroverted uterus through the os, the seat of the laceration suggesting that the pregnancy was but little advanced at the time of the attempt. Puncture of the uterus often results from the uterine sound being employed injudiciously, although no serious symptom may result immediately. Wounds in the fundus and in the vaginal walls point to the introduction of an instrument by inexperienced hands.

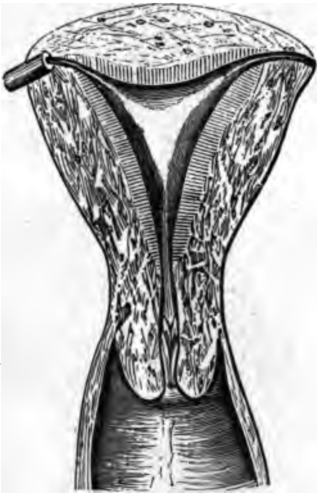
FIG. 43.



Shows—*a*. Vulva. *b*. Sphincter vaginæ. *c*. Commencement of vagina, extending as far as—*g*. Os uteri. *d*. Posterior raphé, showing the rugose vaginal walls. *d*. Columnæ rugarum. *e*, *e*. Shows section of anterior wall of the vagina. *f*. Uterus. *h*. Site of ovary. *i*. Ligament of ovary. *j*. Fallopian tube. *k*, *k'*. Fimbriated extremities of the Fallopian tubes. *l*, *l*. Round ligaments. *m*, *m*. Anterior layer of the broad ligament. *n*, *n*, *n*. Posterior layer of the broad ligament.

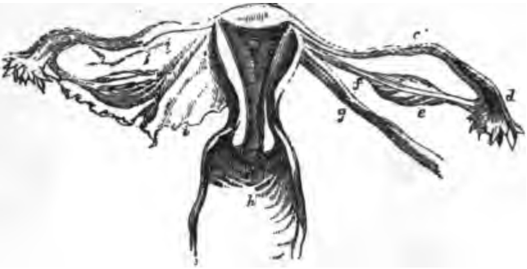
The Figures 41, 42, 43, 44, 45, 46, 47, may be found useful in connexion with this subject, since they show the relations of the parts in the pelvis, and the structure and situation of the various parts.

FIG. 44.



Section showing vagina, uterus, and entrance to Fallopian tubes.

FIG. 45.



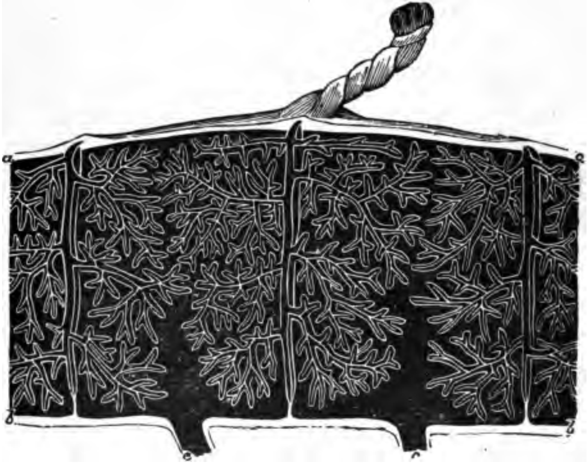
The Uterus, Fallopian Tubes, and Ovaries. The uterus is laid open mesially and anteriorly. *a.* Fundus of the uterus. *b.* Os tincæ. *c.* Fallopian tube (left) laid open. *d.* Fimbriated extremity of the Fallopian tube. *e.* Ovary (left). *f.* Ligament proper of the ovary. *g.* Ligamentum teres (round ligament) of the uterus. *h.* Portion of the vagina laid open. *i.* *Portion of the peritoneum.*

INFANTICIDE.

The murder of a new-born child, or infanticide, is tried by the same rules as any case of felonious homicide. The term " live birth' means that the child must have been alive after its entire body was brought into the world, and must have had an independent circulation, although the umbilical cord need not have been severed.

In the larger works upon this subject will be found minute descriptions of the development of the embryo and fœtus, but it will suffice for our present purpose to give the distinctions between a child at six or seven months and that at the full term.

FIG. 46.



Diagrammatic vertical section of the Placenta. *a, a.* Chorion, receiving the umbilical vessels through the umbilical cord, sending out ramified vascular tufts. *b, b.* Attached surface of the decidua or uterine mucous membrane. *c, c.* Orifices of the uterine vessels.

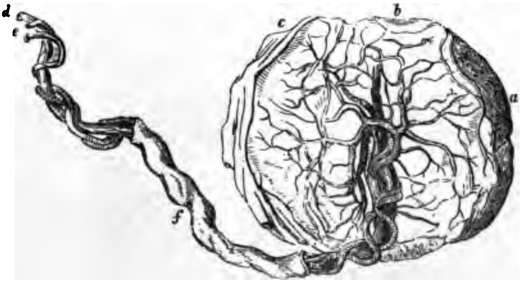
Between the sixth and seventh month the *length* of the child is from 10 to 14 inches ; the *weight*, from 1 to 4 lbs. The skin is of a dusky red colour, and covered with down and sebaceous matter; the membranæ pupillares are disappearing ; the nails do not reach to the ends of the fingers ; meconium may be found at the upper part of the large intestine ; testes near the kidneys. *Points of ossification* in four divisions of the sternum and in the astragalus. At the sixth month the centre of the body is at the lower end of the sternum ; at the seventh month it is a little below the sternum.

At eight months the length of the child is 14 to 18 inches ; *weight*, 3 lbs. 4 ozs. to 5 lbs. 7 ozs. The skin is rosy and covered by fine short hairs with distinct sebaceous envelope ; the nails reach to the end of the fingers and the membranæ pupillares have entirely disappeared; testes have descended into the inguinal ring; a *point of ossification* in last vertebra of the sacrum. The middle of the body is nearer to the umbilicus than to the sternum.

At nine months, or full term, the *length* of the child is 16 to 20 inches; the *weight*, 4 lb. 5 ozs. to 7 lb.; down absent except about shoulders; body covered by sebaceous matter; hair about an inch long on the head; testes have passed the inguinal ring; nails reach to ends of fingers; meconium at termination of large intestine; *points of ossification* in the centre of the cartilage at the lower end of the femur; four portions of the occipital bone distinct, and the meatus auditorius externus cartilaginous.

Women accused of infanticide are tried by the same rules of evidence as in other trials for murder, but, if acquitted, they may be tried in England for concealment of the birth, and, if proved guilty, are liable to imprisonment for a term not exceeding two years. In Scotland, however, a woman may be put upon her trial for concealing her pregnancy, whether she be married or unmarried, if she has concealed her pregnancy during the whole time, and has called in no assistance at the birth.

FIG. 47.



A portion of the Umbilical Cord and the fœtal surface of the human Placenta in the normal state. *d.* The umbilical vein, conveying to the fœtus the blood which has circulated in the placenta. *e.* The umbilical arteries, carrying a great part of the blood of the fœtus to the placenta, and passing to the surface of the placenta, in which they ramify and anastomose. *f.* Part of the umbilical cord enclosed in its membranous sheath; in order to expose the arteries and umbilical vein it has been stripped from the rest of the cord. *c*, *b*. Margin or circumference of the placenta, the chorion and amnion left adhering. The chorion is the deeper; the amnion, more superficial.

The law in these cases also provides that it shall not be necessary to prove whether the child died before, at, or after its birth.

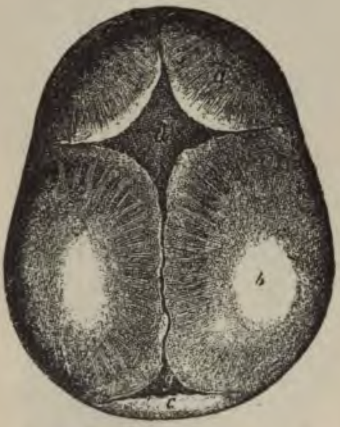
For ascertaining the age of a fœtus by its length, the following rule has been given:—The length, at different ages, during the first six months of intra-uterine life is indicated in centimetres by the *square* of the numerical figure of the corresponding month. The *fœtus at the end of the first* month measures 1 centimetre = ⅓ inch;

the second month, 4 centimetres = 1⅓ inch; the third month, 9 centimetres = 3 inches; and so on. At the seventh month it measures only 40 centimetres = about 13 inches.

Progress of Ossification in the Fœtus.—The first ossific point appears, at about the *sixth week*, in the clavicle, and this is rapidly succeeded by another in the inferior maxilla, then successively in the vertebræ, humerus, femur, ribs, and occipital bone.

At the commencement of the *third month* ossification begins in the scapula, frontal bones, radius, ulna, tibia, fibula, and the superior maxilla. At the end of this month it may be observed in the metacarpal, metatarsal, and phalangeal bones, together with the majority of the cranial bones.

FIG. 48.



Fœtal Head. Vault of Cranium. *a.* Frontal bone of the right side. *b.* Parietal bone (right parietal protuberance). *c.* Occipital bone. *d.* Anterior fontanelle. *g.* Posterior fontanelle.

During the *fourth month* ossification commences in the iliac bones, and in those of the internal ear, with the upper part of the sacrum.

In the *fifth month* the ethmoid, pubis, ischium, and calcanean bones begin to ossify.

In the *sixth* and *seventh months* the astragalus begins to ossify.

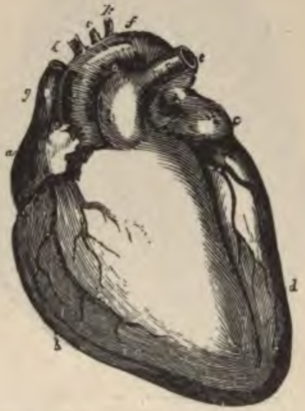
In the *eighth month* the last bone of the sacrum, and sometimes the hyoid bone, begins to ossify, but the os hyoides is frequently not ossified even at full term.

At the *ninth month* the occipital bone still continues in four portions. Ossification has taken place in the external auditory canal; the last piece of the coccyx, the carpus, the patella, the five small tarsal bones, the epiphyses of the long bones, and the sesamoid bones are still in the cartilaginous state.

The fœtal head and vault of cranium are shown in Fig. 48.

Adult Circulation.—In the adult, and in the child who has breathed for some time separate from the mother, the *heart* consists of four chambers, all apart from one another—*i.e.*, of two hearts: a right or pulmonary heart, which consists of two chambers, the upper chamber, or right auricle, into which the superior and inferior vena cava enter, respectively returning the blood from the head and upper extremities, and from the trunk and lower extremities. This upper chamber opens, by means of the tricuspid valve, into the right ventricle or lower chamber, from which, by means of the pulmonary artery, the blood is pumped all over the lungs. Three semilunar or sigmoid valves guard the opening of the pulmonary artery. The blood returning from the lungs flows into the left auricle or upper chamber of the left or systemic heart, through the pulmonary veins, and thence flows through the mitral or bicuspid orifice into the left ventricle or lower chamber of the left heart, which by means of the aorta pumps it all over the body with the exception of the lungs. A triple valve, termed aortic, sigmoid, or semilunar valve, guards the orifice of the aorta. There is no admixture of venous or de-oxygenated, and arterial or oxygenated, blood. In the fœtal circulation this admixture does, however, take place.

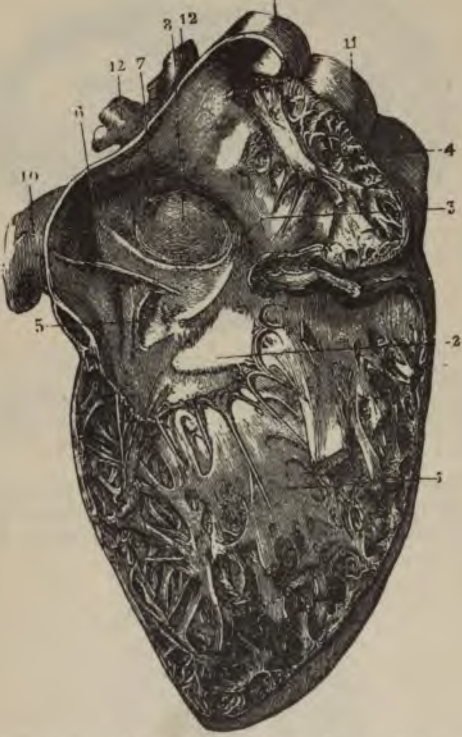
FIG. 49.



The Heart (anterior surface). *a.* Right auricle. *b.* Right ventricle. *c.* Left auricle. *d.* Left ventricle. *e.* Pulmonary artery (left branch). *f.* Summit of the arch of the aorta. *g.* Vena cava superior. *h.* Origin of the brachio-cephalic artery. *i.* The left common carotid artery. *k.* The left subclavian artery.

The Figures 49 to 53 may serve to illustrate adult circulation. Fig. 49 shows the anterior surface of the heart with its structure. Fig. 50 presents a vertical section of the heart n Fig. 51 are

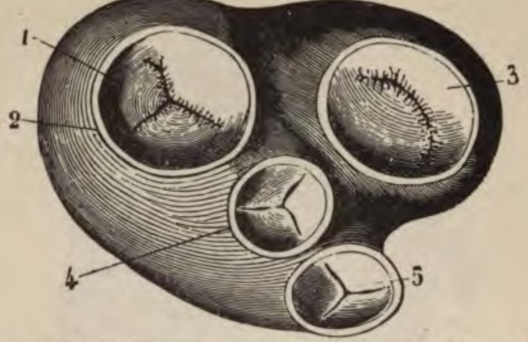
Fig. 50.



Vertical Section of the Human Heart. Venous Cavities of the Heart. 1. Interior of the right ventricle, showing the fleshy columns (carneæ columnæ) by which the walls are strengthened. 2. Portion of the tricuspid valve, which, on rising up during the contraction of the ventricle, closes partially the opening leading into the auricle. The tendinous cords (cordæ tendineæ) attached to the fine edges of the valve prevent this structure returning too far towards the auricle, these tendons being attached by their other extremities to the fleshy columns and fleshy walls of the ventricle. 3. Cavity of the right auricle. 4. Fleshy columns, strengthening the walls of the cavity. 5. Orifice of the great coronary vein, returning the blood from the tissue of the heart itself to the cavity of the auricle. 7 and 8. Oval fossa (fossa ovalis), in the bottom of which may be observed the remains of the opening (foramen ovale) by which, in the fœtus, the two auricles communicate directly with each other. 9. Orifice of the vena cava superior. 10. Trunk of the inferior vena cava. 11. The aorta. 12, 12. The pulmonary veins.

seen the valvules of the heart and arteries. Figs. 52 and 53 represent theoretical sections of the human heart in order to explain the mechanism of the play of the valves. Fig. 54 shows the fœtal heart.

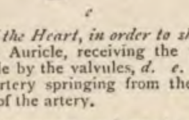
FIG. 51.



Valvules of the Heart and Arteries, the upper surface of the heart, i.e., the auricles, having been removed. 1. Auriculo-ventricular orifice, closed by the tricuspid valve. 2. Fibrous ring surrounding the orifice. 3. Left auriculo-ventricular orifice, surrounded by a ring, and closed by the mitral valve. 4. Orifice leading into the aorta from the left ventricle, closed by the semilunar valves. 5. Orifice leading into the pulmonary artery from the right ventricle, also furnished with three semilunar valves.

Fœtal Circulation.—In the fœtus the blood starting from the placenta goes by the umbilical vein, conveying arterial blood along the cord into the abdomen of the child and up to the liver; part of the blood goes to that organ and part passes along through the ductus venosus to the vena cava ascendens, whence it enters the right auricle; it then passes through the foramen ovale to the left auricle, and thus enters the left ventricle, while the right

FIG. 52.



Theoretical Section of the Heart, in order to show the mechanism of the play of the Valves. *a*. Auricle, receiving the veins *b*, *b*. *c*. Ventricle, separated from the auricle by the valvules, *d*. *e*. Fleshy bundles or stays of these valvules. *f*. Artery springing from the ventricles. *g*. Valvules situated at the entrance of the artery.

ventricle is filled with the blood which is received by the right auricle from the vena cava descendens. By the contraction of the two ventricles, the aorta is directly filled by the left ventricle and indirectly also by the right, through the intermediary pulmonary artery and the ductus arteriosus. Through the aorta the blood passes downwards to the trunk and lower extremities, and

FIG. 53.

Theoretical Section of the Heart in Man.

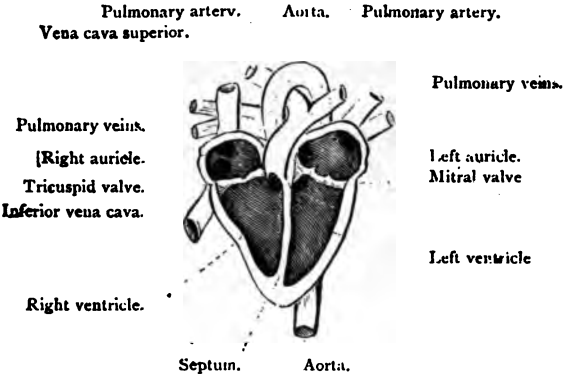
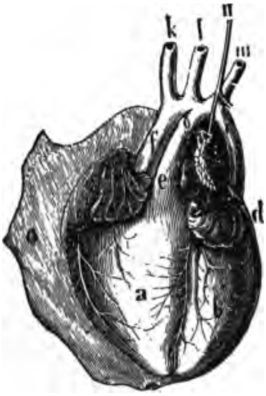


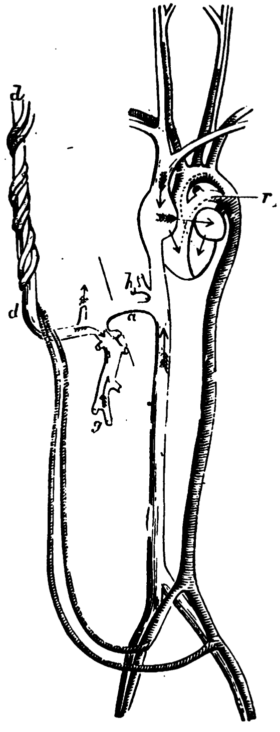
FIG. 54.



Fœtal Heart. *a.* Right ventricle. *b.* Left ventricle. *c.* Right auricular appendix. *d.* Left auricular appendix. *o.* Pericardium (reflected). *e.* Pulmonary artery. *f.* Aorta. *g.* Ductus arteriosus. *k.* Innominate artery. *l.* Left carotid artery. *i.* Aorta. *m.* Left subclavian artery. *n.* Pneumogastric nerve.

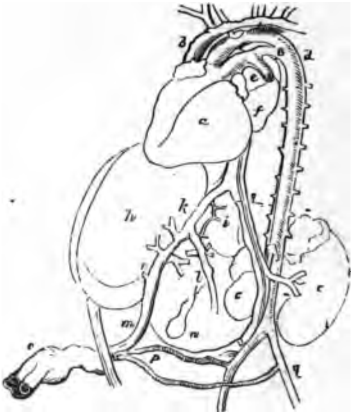
upwards to the head and upper extremities. As soon as it reaches the internal iliacs, the blood speedily departs from the abdomen through the umbilical arteries (now conveying venous blood), and in this manner arrives at the placenta, from which it started. Figs. 55 and 56 represent the course of the fœtal circulation, in the

FIG. 55.



Course of the Fœtal Circulation. a. The ductus venosus. d. Umbilical vein. g. Part going to the liver. h. Vena cava. r. Ductus arteriosus.

FIG. 56.

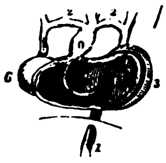


The Fœtal Circulation. a. Left ventricle. b. Vena cava superior. e, f. Left auricle. c lies upon the aorta, close to the entrance of the ductus arteriosus. d. The aorta. q. The iliacs, giving off the umbilical arteries. p. Right umbilical artery. o. Umbilical cord, cut through a short way exterior to the umbilicus. m. The umbilical vein. h. Lower surface of the right lobe of the liver. k. Ductus venosus. i. Lobulus Spigelii. l. Vena portæ. n. Gall-bladder. g. Vena cava inferior. c, c. Kidneys and supra-renal capsules.

former of which, at *d*, is seen the umbilical vein, bringing oxygenated blood from the placenta to the fœtus, part going together with that collected from the intestines into the liver, as shown at *g*, and eventually entering the vena cava at *h*, the larger part going direct through the ductus arteriosus, *a*, to the vena cava, and so on by the right auricle to the heart, then by the foramen ovale to the left auricle, and on to the left ventricle, thence passing to the head and upper extremities.

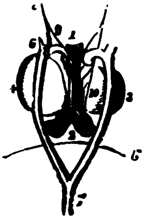
Great changes take place after birth in the course of the circulation. Simultaneously with the first inspiration the air cells of the lungs are opened up, and a much larger amount of blood passes into them. The ductus arteriosus is no longer necessary, and is stretched by the distension of the pulmonary artery. It ultimately becomes obliterated. At the same time the right auricle propels the whole of its blood into the right ventricle. The left auricle becomes filled with blood from the four pulmonary veins, and, becoming gorged, the foramen ovale is closed by the blood in its effort to

FIG. 57.



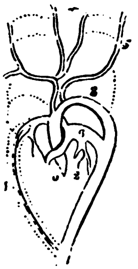
A. *Heart seen on the Ventral Surface, and laid open.* Heart of the Human Embryo (fifth week). 0. Bulbus arteriosus. 2. Arterial canal on each side, uniting behind to form the aorta. 3. Auricular portion of the heart. 4. Opening leading from the single auricular cavity (3) to the single ventricular cavity (6). 5. Septum of the ventricles commencing. 1. Vena cava inferior.

FIG. 58.



B. *Back View of the same Heart.* 1. Larynx and trachea. 2. Lungs. 3. Ventricular, and 4. Auricular part of the heart. 5. Diaphragm. 6. Single ventricular cavity. 7. Descending aorta, formed by the union of the right and left aortic arch. 8, 9, 10. Trunk and branches of the pneumogastric nerves.

FIG. 59.



0. Two tubes resulting from the division of the arterial bulb. 3. Arch of the left side remaining as an arch of the aorta. 4, 5. Great vessels arising from it. 1, 2. Pair of arches sending branches into the lungs, and forming the right and left divisions of the pulmonary artery. 6. Corresponding part of left arch, forming the ductus arteriosus.

flow backwards into the right auricle. In a short time a perfect septum is formed between the two auricles. The circulation through the umbilical arteries becoming arrested, these shrivel up from their origin at the internal iliac artery, and the same occurs with the umbilical vein and ductus arteriosus

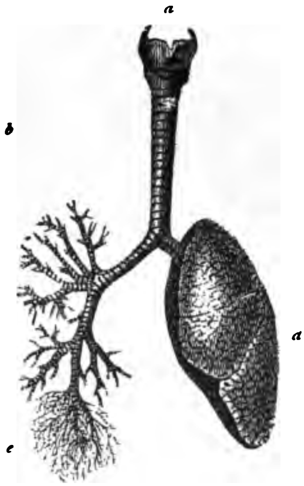
The heart in the embryo appears first as an elongated tube or sac having one arterial trunk proceeding from it in front, and two veins connected with it behind. This tube soon becomes curved upon itself. The organ becomes gradually like that of the fish, being divided into three compartments—auricular, ventricular, and arterial bulb. The next change is the subdivision of the three cavities into six, with the formation of two auricles, two ventricles, and two arteries, the pulmonary and aortic—*i.e.*, the septa of the auricles and of the ventricles are formed and the bulb divides into two. (See Figs. 57, 58, and 59.)

EVIDENCES OF LIVE BIRTH.

The signs of live birth are the following :—

Previous to Respiration, divided into negative and positive.

FIG. 60.



Lungs and Trachea in Man. *a.* Larynx and superior extremity of the trachea. *b.* The trachea. *c.* Division of the trachea into bronchi. *d.* One of the lungs. *e.* Bronchial ramusculæ.

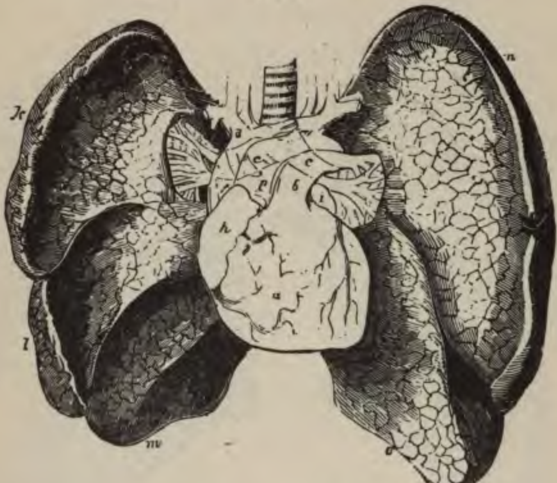
Negative, when evidence is found of the child having undergone maceration in the womb.

The signs of **Uterine Maceration** are : Flattening and flaccidity of the body, prominence of the ilia, soft and yielding condition of the head, more or less detachment of the cuticle, the skin of a brownish-red colour, and covered with soapy fluid, the cavities filled with a large amount of bloody serum, the umbilical cord flaccid and straight.

The signs are **positive** when injuries are observed on the body of such a nature as could not by any possibility have been caused during birth, and accompanied by such hæmorrhage as could only have taken place while the blood was circulating.

Subsequent to Respiration, the evidences are generally obtained from the state of the lungs, although indications may be given by some other organs. Before respiration the lungs are situated at the back of the thorax, and do not occupy the whole of that cavity; after respiration, however, they fill the entire thorax. The portions in which air is contained present a light red colour, which becomes scarlet, and they crepitate beneath the finger. A mottled appearance is presented by the lungs, this being due to arteries and veins surrounding islands of aërated tissue. The diaphragm, *g*, Fig. 64, previous to respiration, is more arched, and ascends higher in the thorax than after this act has taken place. In a child that has *breathed it* has been recorded that uric-acid crystals have been found

FIG. 61.



The Anterior Surface of the Lungs, with the Heart in situ. *a*. The heart, right ventricle. *h*. Right auricle. *b*. Pulmonary artery. *p*. Aorta. *c*. Left bronchus. *d*. Junction of the venæ innominatæ. *i*. Pulmonary veins. *k*. Right lung, upper lobe. *l*. Middle lobe. *m*. Inferior lobe. *n*. Left lung, upper lobe. *o*. Inferior lobe.

reach to the end of the fingers and the membranæ pupillares have entirely disappeared; testes have descended into the inguinal ring; a *point of ossification* in last vertebra of the sacrum. The middle of the body is nearer to the umbilicus than to the sternum.

At nine months, or full term, the *length* of the child is 16 to 20 inches; the *weight*, 4 lb. 5 ozs. to 7 lb.; down absent except about shoulders; body covered by sebaceous matter; hair about an inch long on the head; testes have passed the inguinal ring; nails reach to ends of fingers; meconium at termination of large intestine; *points of ossification* in the centre of the cartilage at the lower end of the femur; four portions of the occipital bone distinct, and the meatus auditorius externus cartilaginous.

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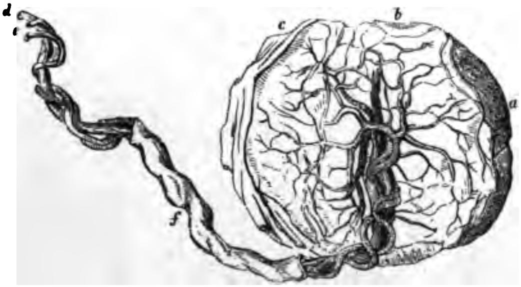
FIG. 47.



A portion of the Umbilical Cord and the fœtal surface of the human Placenta in the normal state. *d.* The umbilical vein, conveying to the fœtus the blood which has circulated in the placenta. *e.* The umbilical arteries, carrying a great part of the blood of the fœtus to the placenta, and passing to the surface of the placenta, in which they ramify and anastomose. *f.* Part of the umbilical cord enclosed in its membranous sheath; in order to expose the arteries and umbilical vein it has been stripped from the rest of the cord. *c*, *b*. Margin or circumference of the placenta, the chorion and amnion left adhering. The chorion is the deeper; the amnion, more superficial.

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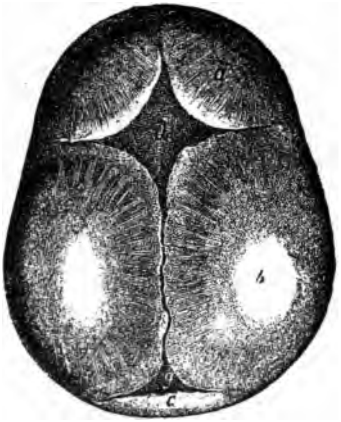
FIG. 48.



Fœtal Head. Vault of Cranium. *a.* Frontal bone of the right side. *b.* Parietal bone (right parietal protuberance). *c.* Occipital bone. *d.* Anterior fontanelle. *g.* Posterior fontanelle.

During the *fourth month* ossification commences in the iliac bones, and in those of the internal ear, with the upper part of the sacrum.

In the *fifth month* the ethmoid, pubis, ischium, and calcanean bones begin to ossify.

In the *sixth* and *seventh months* the astragalus begins to ossify.

In the *eighth month* the last bone of the sacrum, and sometimes the hyoid bone, begins to ossify, but the os hyoides is frequently not ossified even at full term.

At the *ninth month* the occipital bone still continues in four portions. Ossification has taken place in the external auditory canal; the last piece of the coccyx, the carpus, the patella, the

the size of peas, or in strings of small vesicles, resembling a fine mercurial injection beneath tissue-paper. Gentle pressure with the finger will break down the vesicles, but no amount of pressure will drive the air out of the air-cells or alter their appearance in any way.

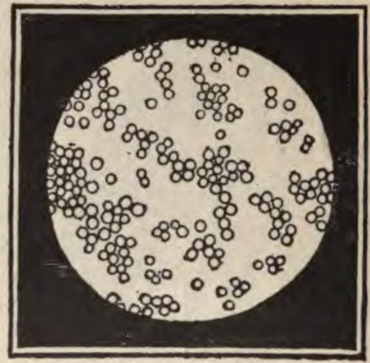
In Fig. 65 are seen the air-cells (known by their peculiar shape and grouping), the dark, isolated melanotic spots, the fainter spots of effused blood, and the large circular spots and string of small, light, round dots, denoting the air-bubbles.

Additional evidence of live birth may be derived from the following facts:—The **Stomach** may contain milk (Fig. 66) or food. The **Large Intestines** in children born alive are usually empty; in still-born children they are filled with meconium.

FIG. 65.

Putrefaction of Lung, showing air-cells, melanotic spots, effused blood, and air-bubbles.

FIG. 66.



Pure Milk, showing oil globules (magnified 400 diameters).

The **Bladder** is, as a rule, emptied soon after birth, at which time also the **Skin** is in a state of desquamation.

In the **Organs of Circulation** certain changes take place after birth, and their extent will throw some light upon how long the child may have lived.

Within a few seconds after birth the **ductus arteriosus** commences its contraction, and it attains somewhat the size of a crow-quill at the end of a week, becoming obliterated about the tenth day.

Obliteration of the **foramen ovale** takes place at very variable periods, and may remain patent even in adult life.

The calibre of the **umbilical arteries** is conspicuously decreased at the end of twenty-four hours, and after three days these vessels become obliterated nearly up to the iliacs. About the fifth day the ductus arteriosus and the umbilical vein are usually completely contracted.

The **Umbilical Cord.**—In a new-born child this cord is round, firm, fresh, and of a bluish colour, blood being contained in its vessels. Rupture of the cord may ensue in a precipitate labour in consequence of the child falling from the mother, and still the appearance of being cut may be presented by the ruptured portions. It is very rare indeed for a child to bleed to death when the cord is cut, ruptured, or left untied.

The following changes take place in the umbilical cord:—

1. **Mummification** or shrinking, from the ligature towards the umbilicus (navel). This is an early change, which is seldom protracted beyond thirty hours, the cord itself becoming flabby, and presenting an inflammatory ring around its insertion.

2. **Desiccation.**—The cord becoming reddish-brown, then shrivelled and flattened, then of the colour of parchment, falling of about the fifth day.

3. **Cicatrisation.**—This results from the tenth to the twelfth day.

Positive evidence of live birth may be deduced from the presence of the bright-red rim surrounding the insertion of the cord, accompanied by inflammatory thickening and slight purulent secretion. The probable length of time that the child has lived after birth may be inferred from the stage which the separation of the cord has reached through the process of ulceration.

CAUSES OF DEATH OF THE FŒTUS.

1. The fœtus may die by reason of its immaturity; or

2. From complications during, or immediately following, birth, such as the pressure of tumours in the maternal passages; diseases of the maternal bones; from pressure on the cord during labour consequent on malposition of the child; from strangulation through the funis being round the neck, or by falls upon the ground or floor in sudden labours.

When the death of the fœtus has been criminally induced it may have resulted from punctured wounds of the orbits, the fontanelles, the spinal marrow, or the heart, from the head being separated from the body, the neck being dislocated from strangulation, from fracture of the face and head bones, from drowning in a privy, or from strangulation. Infanticide may also result from omission, as neglecting to tie the cord, or to furnish clothes, food, and warmth for the child.

LEGITIMACY.

Every child who is born in wedlock is presumed to have the mother's husband for its father, but the paternity may be disputed upon certain grounds, as the death or absence of the reputed father, want of access, premature delivery in a recently married woman, disease in the husband preventing sexual intercourse, or impotence. In a case where a woman marries again immediately after the death of the husband, when either husband may have been the father, the offspring at twenty-one years of age is allowed to select its father.

Duration of Pregnancy.—The natural period of uterine gestation is regarded as forty weeks, nine calendar months, ten lunar months, or 280 days.

This term may in some rare cases be exceeded, and, again, a child may be born at a shorter period. In many cases considerable difficulty arises in determining the date of conception. It is calculated from the following data:—

1. Peculiar sensations accompanying conception. These are very ill defined and hardly reliable.

2. Cessation of the catamenia. This may, however, be caused by other circumstances, and menstruation may, on the other hand, take place during the whole pregnancy. The menses may be checked by cold at one monthly period, and pregnancy take place before the next period, so that an error in this calculation may involve several days or a month.

3. The time of quickening. This is not always noticed, but, when it is, may occur at variable periods—viz., from the tenth to the twenty-sixth week. Quickening may take place without pregnancy, and pregnancy without quickening.

4. A single coitus. This is the only absolutely accurate method of reckoning, but is of necessity very seldom available.

In a case which once came under the author's observation the child was born exactly 281 days after the last or alleged single act of connexion.

Viability of Children.—The earliest period at which a child can be born which is capable of living and reaching maturity is usually regarded as seven months, or 210 days. Still, cases are on record of children being reared who were born at six months.

The following are the signs of

Maturity: There are strong movements and cries directly after birth; the body is of a clear red colour, being covered with sebaceous matter; the mouth, eyelids, nostrils, and ears open; the hair, nails, and eyebrows completely developed; the skull somewhat firm; the fontanelles not far apart; the testicles have descended; there is a free discharge of meconium and of urine; power of suction shown by the seizure upon the nipple or a finger placed in the mouth.

Immaturity: The head is out of proportion to the body, the centre of which is high; membranæ pupillares are present; the testicles have not descended; the parts of generation are deep red in colour; the skin intensely red and mottled, coated by a downy covering; the nails not perfectly formed; movements feeble; inability to suck; artificial heat necessary; the sleep almost unbroken; the discharges of meconium and urine infrequent and imperfect; mouth, eyelids, and nostrils closed.

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SUPERFŒTATION.

This term implies the conception of a second embryo by a woman who is already pregnant, the result being the birth of two children simultaneously, but presenting considerable difference in the extent of their maturity, or in two separate births with a considerable interval. At one time it was supposed that the os uteri closed immediately upon conception, but this has been shown not to be the case, and if an ovum happens to escape into the uterus it is likely to become impregnated even a month or more after a previous conception.

Well-authenticated cases are on record of women bringing forth fully formed twins of different colours: in one case one child was *black* and the other *white;* in another case, one a *negro,* and the other a *mulatto;* in both these cases it was admitted that connexion took place with two men of different races, one directly after the other. In another class of cases the birth of the two children is separated by a short interval, or by an interval which corresponds closely to their relative size and development to be explained by the supposition of their being twins, and the expulsion of twins at different times is admitted to be a common event. There are cases, however, which appear to countenance the theory of a double conception, as in the case of a woman who was delivered of a living child five months and sixteen days after the birth of another child, no sexual intercourse having taken place with the husband until twenty days after the first birth. Had the child been the result of this intercourse, its age would have been only four months and twenty-seven days. A well-authenticated case is also related in which a woman was delivered of two male children (both born perfect) at an interval of nearly three calendar months.

Some cases of superfœtation may be explained by the existence of double uteri, and more rarely of double vaginæ also. A woman six months after marriage gave birth to a four months' child, and forty weeks after marriage to mature twins. In this case each vagina had a separate orifice, and the uterus and vagina were also found to be double.

With regard to how soon after delivery a woman may again become pregnant, it has been stated that the fourteenth day after delivery is the earliest date at which a fresh impregnation may occur.

INHERITANCE.—That a child should inherit, it must be born alive, and must be born during the mother's lifetime. Monsters are incapable of inheriting.

"Tenancy by courtesy" is a mode of inheritance such as follows:—"When a man marries a woman seised of an estate of inheritance, and has, by her, issue born alive, which was capable of inheriting her estate; in this case he shall, on the death of his wife, hold the lands for his life as tenant by the courtesy of England," any kind of motion being held as evidence of live birth in questions of tenancy by courtesy, so that in this instance the meaning of the words "born alive" is not the same as in cases of infanticide.

FEIGNED DISEASES—MALINGERING.

These may be of two kinds—factitious, which the malingerer contrives to produce; and fictitious, which he alleges he suffers from. To the **Factitious** class belong external injuries, defects, and diseases, fractures, wounds, ulcers, discharges, malformations, and others; to the **Fictitious** class, groups of symptoms of which a pretence of suffering is made, such as spasms, palsies, convulsions, rheumatism, defects of senses, or such affections as consumption, epilepsy, and fever.

Many devices are resorted to by the malingerer to produce factitious injuries: prisoners will place their limbs under locomotives or machines; to occasion various forms of tumour, air is sometimes injected, ligatures and pressure applied, and effervescing mixtures swallowed; sores and diseases of the eye are sometimes created by various irritating substances; bruises have been imitated by colouring matters; to simulate different varieties of prolapses and malignant diseases, sponge dipped in colouring matter and the viscera of animals have been employed. Diarrhœa has been set up by soap pills, and discharge of blood occasioned by puncture of the gums. Factitious worms and foreign bodies have been placed in the urine, or into matters expectorated, vomited, or otherwise passed from the body.

Paralysis is frequently assumed; hemiplegia, paraplegia, and partial paralysis may one or all be feigned.

Feigned Epilepsy.—Of the two forms of epilepsy, the slight (*petit mal*) and the severe (*grand mal*) type, impostors generally feign the latter, uttering peculiar cries, struggling, and falling down, causing lividity by holding the breath, and frothing at the mouth by the use of soap or some saponaceous root in the mouth. They frequently leave out the sequelæ of true epilepsy, and their pulse and respirations are but little altered by their exertions. It may also be mentioned that malingerers take good care not to hurt themselves.

The true epileptic is deadly pale, his muscular rigidity only to be overcome with difficulty, the trunk muscles almost as much affected as the others. The pupils are dilated and refuse to contract when exposed to the strongest light. Impostors usually, as in feigned insanity, *overact* their part.

Hysteria, chorea (St. Vitus' dance), and other convulsive neuroses, even tetanus, may be feigned. The genuine cases nearly always appear gradually; valvular disease of the heart frequently accompanies chorea. It is sometimes a matter of great difficulty to distinguish between tetanic spasms arising naturally from those produced by the action of certain poisons, such as strychnine.

When called to what a medical man believes to be a case of malingering, he should not be satisfied with one visit only, but should come again, and be careful to enter unannounced; he should have the patient watched between the visits; should examine every organ separately, comparing its condition with the statement of the patient, and should make note of any discrepancies between the real symptoms of disease and the patient's account of them. He should have all bandages and dressings removed, and indicate, in the patient's hearing, some severe mode of treatment, such as actual cautery. For the detection of some feigned diseases the administration of chloroform is often valuable.

Colour Blindness.—Among disqualifying diseases or defects is *colour blindness*. This is more common among males. There are varieties of this blindness—viz., **red-green** and **blue-yellow**; the former the more common, and of the more importance, in consequence of green and red being the colours used generally for signals.

The methods of testing are as follow:—Skeins of coloured wool are shown to the individual, who is asked to match those of the same colour. He is first required to match a light-green skein from a number of coloured skeins; if he is correct in his selection, his sense of colour-sight is normal. If he is incorrect, a purple skein is given to him, and he is asked to match this. If he matches it with violet or blue, as well as with purple, he is red-blind; if with grey or green, he is green-blind; if with orange or red, he is blue-blind. Still further, he may be given a red skein in order to match it. If he is green-blind, he will match it with brown and green shades, brighter than the pattern; if red-blind, he will match it with brown and green shades darker than the pattern.

UNSOUNDNESS OF MIND.

The following four classes were included by Lord Coke under the term *non compos mentis*—viz.:

"1. *Idiota*, which from his nativity, by a perpetual infirmity, is *non compos mentis*.

"2. He that by sickness, grief, or other accident wholly loseth his memory and understanding.

"3. A lunatic that hath sometimes his understanding and sometimes not, *aliquando gaudet lucidis intervallis*, and, therefore, he is called *non compos mentis* so long as he hath not understanding.

"4. He that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken."

In English law a criminal is absorbed from all guilt on the ground of madness, but in order to excuse from punishmont it must be proved that he was incapable of distinguishing right from wrong, and that at the time of committing the crime he did not know that his offence was against the laws of God and *nature*.

With reference to testimony in relation to crime, lunatics are competent witnesses if they understand the nature of an oath and of the proceedings in which they are taking part. The judge examines the lunatic brought as a witness, as to whether he comprehends the obligation of an oath, and, if satisfied, may permit him to be sworn.

No person, medical man or other, is allowed to receive more than one certified patient at a time into his house, unless the house is licensed by the Commissioners in Lunacy; the receiver must hold the proper medical certificates of such a person's lunacy; and within *one clear day* of a patient's reception the notice of admission must be transmitted to the Commissioners. If a patient (not of unsound mind) is received into a house, and such patient subsequently becomes insane, the proper certificates of insanity must be at once procured; otherwise the person keeping such a patient renders himself liable to very heavy penalties.

The following classification of unsoundness of mind is given by Dr. Guy:—

AMENTIA.	DEMENTIA.	MANIA.		
1. Idiocy	1. Acute or primary	1. General		
2. Imbecility	2. Chronic or secondary	2. Intellectual	General	
			Partial	Monomania Melancholia
		3. Moral	General	
3. Cretinism	3. Senile dementia		Partial	Homicidal Suicidal, &c. &c.
	4. Paralytic dementia, or general paralysis of the insane			

AMENTIA, IDIOCY, AND IMBECILITY.

Idiocy may be defined as mental deficiency or extreme stupidity; dependent upon disease or malnutrition of the nervous centres occurring either before birth or before the evolution of the mental faculties in childhood.

An **Idiot** is a being who becomes irretrievably defective in mental power, and is incapable of co-ordinating the functions of his brain, by reason of some cerebral abnormality existing before the brain has attained its full size, and the mind its full capacity.

Imbecility is a term generally applied to the condition in which the incapacity of the mind is less marked than in idiocy. The mental capacity of the imbecile is usually considered superior to that of the idiot. Imbecility is rarely congenital, idiocy frequently so. The idiot is seldom so destructive as the imbecile, who often exhibits an amount of moral perception and sensibility far in advance of that which the idiot possesses, and out of all proportion to his intellectual capacity.

To summarise briefly:—The mind of the idiot remains undeveloped, except as regards a mischievous tendency; he can neither talk nor walk properly; he is frequently deformed, often deaf, and is unable to take hold of objects. Of the deformities the chief are: wad-shaped fingers, hernia, squinting, abnormal shortness of one or two toes in each foot, peculiar shapes of the ears, club foot, and coloboma of the iris. The head may be unusually small (microcephalic), or unusually large (macrocephalic) or hydrocephalic. The hair on the pubes is usually scanty, and the testicles are at times wanting. The so-called "vaulted palate" commonly accompanies idiocy; in this case the palate is narrow, the height of the palatine arch increases at the expense of the nasal cavity, and the space between the bicuspid and molar teeth of opposite sides is decreased. If the narrowness is extreme, the teeth project beyond the upper lip. The lips of an idiot are nearly always thick and everted; the mouth is frequently large and gaping. The teeth generally are irregular and decayed, the saliva often dribbles from the mouth, and the gums are swollen. The skin often exhales a disagreeable odour; the habits are dirty, the passions are strong, the appetite is greedy, and there are frequently brutality and obstinacy.

CRETINISM.

may be defined as an arrested development of the nervous system and bodily organisation generally, either before or after birth, due to a local cause, such as the condition of the soil, air, water, &c., and marked by characters which distinguish it from a state of mere endemic idiocy.

This condition is found most commonly in shut-up valleys, in which the air is foul, the soil damp, and the inhabitants poor, dirty, and insufficiently or improperly fed. Water derived from lime sources is considered the chief causative agent. It is usually associated with goître, although not necessarily.

Symptoms.—These generally appear in a marked degree about the sixth month, and are the following:—The progress of growth of the body is very tardy; in some cases cretins are puffy, fat, and weak, although apparently healthy. The skin is sometimes of a brown colour, sometimes of an ashy yellow. The head is often big, the fontanelles opened widely, and occasionally the sutures are disjointed, as in hydrocephalus. Cretins appear to open the eyes reluctantly. Their look is stupid and languid. The countenance continues always the same, altered neither by fear nor joy. They eat much and eagerly. Much of their time is occupied in sleeping, and they are not awakened with ease. The lips are swollen and thick, and usually gaping. The nose is short and broad. The cry is at times hollow and peculiar, and they seldom weep. The belly is swollen. The limbs are usually feeble and small. The neck is thick and large, and often the seat of goître. The intellect is dull and apathetic. Dentition is always late in commencement, and generally goes on for several years longer than in the normal child, and is frequently associated with considerable salivation and alarming convulsions. The teeth are often irregular, blackening, decaying, and falling out. There is seldom ability to stand upright before the second or third year, and walking is scarcely accomplished before the sixth or seventh year. Speech is usually later than walking. After puberty the face of the cretin changes very little, and the cretinous face of fifteen or sixteen years old appears like that of a man or woman of fifty or sixty.

The following differences between the cretin and the idiot are worthy of notice:—

1. The idiot is born with deficient development. This affliction is organic and congenital, but the cretin for some time may appear free from disease, and under favourable conditions may escape entirely.
2. Cretinism is of an endemic character, whereas idiocy is not at all so, but may appear without regard to locality.
3. Cretinism is far more curable than idiocy.
4. The "vaulted palate" is sometimes present in idiots; but in the cretin the yellow or brown colour of the skin, the arched high palate, and the large proportion of cases in which the thyroid gland is enlarged, offer conspicuous points of distinction with the manifestations of ordinary idiocy.
5. In cretinism the muscular and nervous systems are affected in a far greater degree. In idiocy the mental functions may be greatly deficient, out of all proportion to the loss of muscular power and co-ordination.

DEMENTIA.

In dementia the failure of the mental faculties does not occur until the mind has become fully developed.

In *Acute Dementia* there is profound melancholy or stupor, arising from a sudden mental shock, the mind being, as it were, arrested and fixed for the rest of life in abstraction on the event which has occasioned it. The shock may destroy all mental power, and induce a condition similar to that of the idiot or imbecile.

In *Chronic Dementia* there is generally gradual action on the mind of grief or anxiety, or it may follow mania apoplexy, paralysis, or repeated attacks of epilepsy. It may be dependent upon softening or chronic cerebral affections.

Senile Dementia is incidental to aged persons, and comes on gradually with loss of memory for recent events, dulness of perception, and inability to fix the attention. Eventually the memory, the reason, and the power of attention are completely lost, but the muscular force remains unimpaired. Finally, bare physical existence remains.

Paralytic Dementia, General Paralysis (*Paresis*) *of the Insane.*—The most characteristic indication of this malady consists in delusions of great power, exalted position, and unlimited wealth—the so-called delirium of grandeur—which always is accompanied with progressive decay of mind and body. This is rare in women, and is common in men of position and education; generally commences in adults of middle age from thirty to sixty, and it is stated to last from a few months to three years. The paralytic symptoms first show themselves in the tongue, lips, and features; the speech becomes thick and hesitating; the muscles of the face are quivering and tremulous; the pupils frequently unequal; the muscles of the limbs become affected; the patient stumbles or trips, and can no longer exercise combined muscular movements such as writing. The early symptoms are often neglect of duty, commission of petty thefts, extravagant acts, indecent exposure of the person, and sudden change of opinion and feeling, religious and moral. It is said to be caused by intemperance, sexual excesses, anxiety, and hereditary taint; the sphincters are finally involved, and death may occur from suffocation. Sometimes there may be maniacal outbreaks or epileptic fits. The delusions remain unaltered throughout, and the patient's last words will probably relate to his fabulous riches and exalted ideas.

MANIA.

The term mania includes all forms of mental unsoundness which are characterised by undue excitement. There are three divisions—viz., general, intellectual, and moral, the two latter classes being subdivided into general and partial.

In General Mania the intellect, the passions, and emotions are all affected. This form might be correctly called "raging incoherence." It is generally preceded by a period of incubation in which the general health is affected, and this period may vary in duration from a few days to fifteen or twenty years. When the malady is fully developed, the patient exhibits paroxysms of violence both against himself and others; he will tear his clothes to rags, and drink or eat voraciously, or refuse food altogether, and undergoes an amount of muscular exertion without sleep, and apparently without fatigue, by which a healthy person would be completely prostrated. His face is flushed, his eye wild and sparkling, and he complains of ringing in the ears, pain, weight, and giddiness in the head. During an attack the features of the maniac are frequently so altered as to be difficult to recognise.

General Intellectual Mania consists in many instances in a violent disturbance of all the intellectual faculties induced by the over-excitement of some one leading passion or emotion. Three classes may be instanced—one which may be termed "illusional *insanity*," such as the gentleman of Argos of Horace, "who believed he was hearing marvellous tragedies, a happy sitter and applauder in an empty theatre"—

> "Qui se credebat miros audire tragœdos,
> In vacuo lætus sessor plausorque theatro."

In another class, a man will think himself secretary to the moon, or that he is the Crystal Palace, and in a third class the excitement of some strong emotion or passion, as pride, vanity, or love of gain, may fill the mind with intellectual delusions, so that an individual will state that he has composed Homer's "Iliad," or painted a masterpiece of Rubens.

A *Delusion* is an affection of the mind, a chimerical thought, whilst an *Illusion* is an affection of the senses, a counterfeit appearance: thus it is customary to speak of a delusion of the mind, an illusion of the senses. An *Hallucination* is that sensation which is supposed by the patient to be produced by external impressions, although no material object acts upon his senses at the time. An illusion is a sensation produced by a false perception of objects. If the illusion or hallucination is believed by the patient to possess a positive existence, and this belief is not removed upon reflection or by appealing to the other senses, the individual is insane; should, however, the false sensation be instantly discovered by the judgment, and not acted upon as if it had an actual existence, the individual is sane.

Partial Intellectual Mania, or *Monomania*, in its simplest form is a disease of the mind in which the patient becomes impressed with some notion contradictory to common sense and universal experience —viz., that he is a cat or a dog, a goose-pie, or a piece of glass.

Moral Mania has been defined as "a morbid perversion of the natural feelings, affections, inclinations, temper, habits, and moral dispositions, without any notable lesion of the intellect, or knowing and reasoning faculties, and particularly without any maniacal hallucination."

Partial Moral Mania.—In this some one propensity or passion predominates. The forms are the following:—

Kleptomania, a propensity to theft. This is most common in women in prosperous circumstances. A case is on record, however, of a man who would never eat food unless he stole it.

Dipsomania, an insatiable craving for drink—sometimes intermittent, sometimes continuous. The patient is quite rational when the influence of the drink is withdrawn.

Erotomania, or amorous madness. This is called *Nymphomania* when occurring in women, and in men, *Satyriasis.* This uncontrollable desire for sexual intercourse may occur in virtuous females who become filled with horror and remorse.

Pyromania, an impulse to incendiarism, more common in women who are subject to menstrual troubles.

Homicidal mania, a propensity to murder, may exist independently of delusion; it is more common in women, especially when in the condition of mimosis inquieta, and in whom there is an irresistible impulse to crime, with an overwhelming terror of yielding to it.

Suicidal Monomania, or impulse to self-destruction.—Suicide is considered by some authorities to be always a manifestation of insanity, but when, as sometimes happens in France, two persons combine to commit suicide, there would appear reason to believe that occasionally it may be independent of insanity.

Puerperal Mania.—This attacks women who have been recently confined, and is most common between the fifth and fifteenth day. It may be due to extreme weakness, resulting from want of sleep, profuse discharge, or excessive lactation. The symptoms may be those of any variety of mental unsoundness, and in many cases there is a strong homicidal tendency against the child.

Melancholia (*Lypemania*).—Here the chief indication is gloom and depression. The patient is sad, taking no interest in anything, thinks he has committed unpardonable sins, and is often suicidal. The general health is markedly impaired, and sleeplessness is a constant symptom. It is essentially a disease of middle life, hereditary predisposition being the most important causative agent, but it is often attributed to anxiety and overwork, or to some great grief.

Mania with Lucid Intervals.—Mania may in some cases be of an intermittent, or recurrent nature, in the interval the patient being in his right mind. Mania and melancholia often alternate with one another (alternating insanity), the exaltation of mind leading to depression and being followed by a complete intermission.

The occurrence of an absolute lucid interval is denied by some authors.

Instinctive or Impulsive Mania.—This form is now recognised, and has led to the acquittal of an accused person. Here the acts are without apparent motive, a man kills a sister or a wife to whom he is tenderly attached, or some victim whom he never saw before, or may even injure an animal incapable of offending him. He makes no attempt at escape, perhaps openly exposes the body and gives himself up to justice. He may be overcome with remorse, or remains stupid and indifferent, and he takes nothing from his victim.

Before the homicidal acts a remarkable change may be observed in the character and conduct, and upon inquiry the accused person may be found to have suffered from fits, or have attempted suicide, and there may be a history of hereditary insanity.

In the *Epileptic*, violent homicidal impulses are very common, sometimes taking the place of the fits (masked epilepsy), although sometimes following or preceding the attack.

In examining a person of unsound mind, observation of the general appearance, the shape of the head, the expression of the countenance, and the speech, should be carefully noted. In women the state of the menstrual function should be carefully investigated. The family history is of great importance, as is also the period of life at which the unsoundness came on, and whether any cause can be traced for such unsoundness. Is it a first attack? Is the patient epileptic? Is he the subject of delusions, exaltation of ideas, or melancholic? He may be questioned as to common events, day of the month, name of reigning Sovereign. If possible it is wise to make more than one visit. The presence of some well-marked delusion should be carefully looked for, especially the fact of hearing voices at night, which have no existence except in the disordered brain of the person under examination, and which voices may tell him at one time to commit very trifling acts, but at other times will impel him to homicide or suicide.

A Lunacy Certificate.—This form contains an order, statement, and two medical certificates.

The *order* is directed to the person who is about to receive the patient.

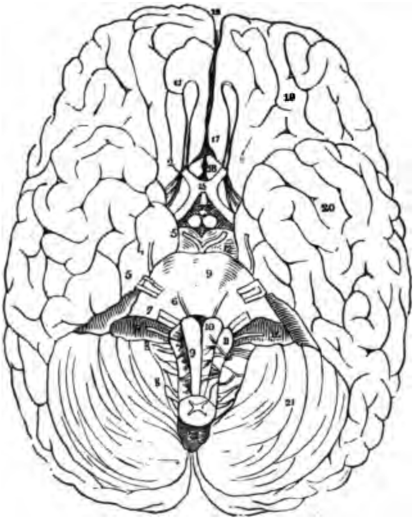
The *statement* sets forth—the particulars of the patient's case, and contains such information as to whether it is the first attack. the condition of life, religious persuasion, whether dangerous, suicidal, or epileptic, and is in fact a history of the person requiring to be placed under care and treatment. The order and statement if possible should be filled up by a relative or friend, but in a case of emergency any one is empowered to sign one or both.

The certificate (except in the case of a pauper patient) requires the signatures of two independent medical men. These medical men must not be any way interested in the patient, must not be in partnership, their visits must be made separately and at different times, and they must write down the facts observed by themselves and those that have been noticed by others, the name of the informants being given upon the proper lunacy form. The certificate only remains valid for the space of seven days. In a very urgent private—*i.e.*, otherwise than pauper—case one medical signature will suffice, but this certificate is valid only for three days, and must then be supplemented by a second.

Some years ago the statement of facts observed by the medical men, apart from those observed by others, was considered sufficient, but the experience of some recent lunacy libel actions has certainly shown that, the facts obtained from others are of vital importance to the certifier as a safeguard, and showing that he has made all possible inquiries. For his own protection it would be better for the medical man to decline to certify unless he can obtain plenty of facts from others, so that in case of future legal proceedings he may call them as witnesses in his behalf. Any person who has been certified as of unsound mind has the power of bringing an action for libel against the certifiers and those concerned in his or her deprivation of liberty, within one clear year after being discharged from care.

Upon the reception of a patient into a licensed house, the Commissioners in Lunacy are apprised of such a reception, and in due course of time they visit the patient and sign the books of the establishment, in which the patient's daily condition is recorded. They then make a note upon the case. This proceeding has proved of great service to the medical men who have certified. In some recent actions brought by patients who have been in asylums against the certifier, the case has resulted in a verdict for the defendant mainly upon these notes of the visiting commissioners and their production at the trial.

FIG 67



The Brain: its Base. .. The optic nerves. 5, 12. Third pair of nerves and crura cerebri. 4. The fourth pair of nerves. 6. The sixth pair of nerves. 7. The seventh pair of nerves. 8. The eighth pair of nerves. 9. The ninth pair of nerves; the figure is placed upon the corpus pyramidale of that side. 10. 11. The olivary and pyramidal bodies of the left side. 14. The glosso-pharyngeal nerve, left side. 15. Commissure of the optic nerves. 16. Portion of the brain connected with the corpus callosum. 17, 17. Olfactory nerves and bulbs. 18. The inter-hemispherical fissure. 19. The inferior surface of the anterior lobe, left hemisphere. 20. Middle lobe of the cerebrum. 21. Cerebellum. 22. The infundibulum and corpora albicantia.

If a person is afflicted with unsoundness of mind sufficient to render him incompetent to manage his affairs, the law may step in and require a so-called Commission in Lunacy upon him in order to protect such person and the property from injury. This proceeding may merely entail such restraint as will be necessary for the protection of the individual, and does not always imply deprivation of personal freedom; in fact, some patients reside in their own houses, but of course under proper supervision.

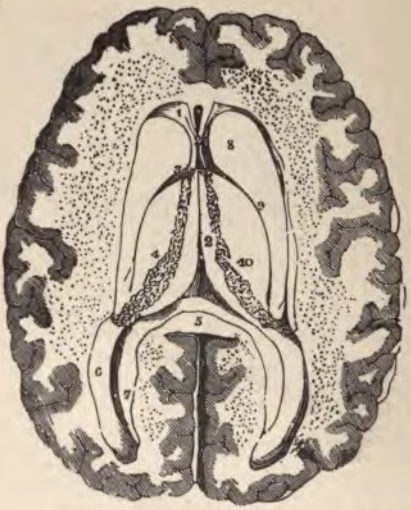
Upon affidavits from medical men, and the settlement of certain legal details, a commission is in general granted by the Court of

Chancery. The alleged lunatic whose case is under investigation has the right of claiming to be tried by a jury. If he or she is found lunatic by this court, two so-called committees are appointed, one termed the Committee of the Estate and the other the Committee of the Person—the former having the care of the pecuniary affairs and the latter of the person of the lunatic.

MORBID APPEARANCES IN THE BRAIN OF THE INSANE.

The most important deviations from health in the insane are to be found in the brain, and the following conclusions of Griesinger are interesting :—

FIG. 68.



The Brain : its Interior (lateral ventricles laid open). 1. Portion of the fornix. 2. Septum lucidum, its ventricle has been laid open. 3. Tænia semicircularis of Haller. 4. Thalamus nervi optici, left side. 1—3. Fornix, upper surface, concealing in its present position the velum interpositum. 6, 7. Hippocampus and descending horn of the lateral ventricles. 8. Choroid plexus. 9. Tænia semicircularis, right side. 10. Choroid plexus, right side.

I. **In Acute Insanity.**—The brain may be found apparently quite healthy.

Anæmia, with serous infiltrations, or hyperæmia, especially of the grey matter is common. The membranes are frequently thickened.

In melancholia the brain is very often anæmic, but it is more often found healthy in melancholia than in mania.

In mania there is *usually* some anatomical change.

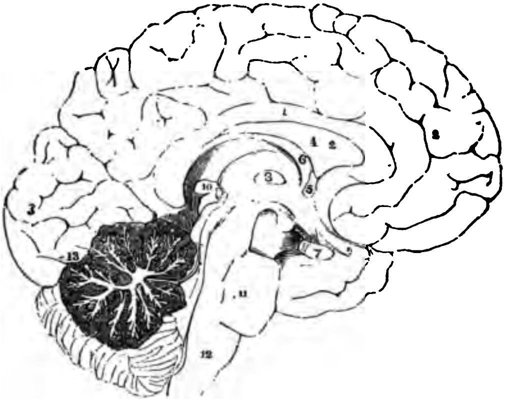
II. **In Chronic Insanity.**—Some anatomical lesion is nearly always present.

Hyperæmia and thickening of the membranes are common—as are also atrophy of the brain, especially of the convolutions, chronic hydrocephalus, effusion into the sub-arachnoid space, pigmentations of the cortical substance, deep and extensive sclerosis.

The above-mentioned conditions are not found in acute cases.

Softening may be present, but more frequently pigmentation of the superficial layers, superficial induration and adhesion of the pia mater in various degrees are observed.

FIG. 69.



Vertical Section of the Mesial parts of the Brain, Cerebellum and Pons Varolii. 1. Corpus callosum. 2. Inner surface of the anterior lobe of the left hemisphere. ·3. Posterior lobe of the same hemisphere. 4, 2. Septum lucidum. 6, 5. Fornix. 7, 9. Infundibulum and corpus albicans of that side. 8. Soft commissure and cavity of the third ventricle. 10 Pineal gland and corpora quadrigemina. 11, 12. Pons Varolii and medulla oblongata. 13. Arbor vitæ of the cerebellum.

In many cases the walls of the ventricles become inflamed, granular, and adherent.

Hyperæmia, unless it be *hyperæmia ex vacuo* is rare in chronic cases; the more or less hypertrophied brain is œdematous and anæmic.

In dementia (profound mental weakness) considerable atrophy of the brain is usually to be noticed.

III. **In Paralytic Dementia.**—Sometimes there are no macroscopical (naked eye) changes, but always microscopical ones. Coarse changes are rarely absent.

Great œdema of membranes, adhesion of the pia mater, greyish-red softening, coloration, partial or superficial induration of the cortical substance, increase of the connective tissue, with destruction of true nervous matter (tubes and cells), are common changes.

The brain is usually much atrophied, the convolutions indistinct and flattened. The connective tissue in the white matter is much increased. Pachymeningitis, or inflammation of the dura-arachnoid, meningeal apoplexy, and degeneration of the cerebral arteries are all common.

In many cases the spinal cord becomes implicated by extension of the degeneration of brain cells, increase of connective tissue, &c.

Such constant lesions are shown in no other form of insanity. They are, however, not always the same in all cases, but are varied.

Insanity, then, may exist without any appreciable abnormality; in the majority of cases, however, anatomical lesions are observed either in the brain or its membranes, or in both, and these lesions sometimes extend to the spinal cord.

Insanity is often complicated with other diseases, especially tuberculosis. Figs. 67, 68, and 69 may be of service in the comprehension of some of the above statements, as also of the section devoted to injuries.

A portion of the third frontal or superior marginal convolution, together with the parts about the insula, is supposed to be the special region of articulate speech. In aphasia it is the part usually affected. Aphasia is most common with hemiplegia of the right side. In a large majority of cases the lesion (clot or embolism) is to be found on the opposite or left side of the brain, but care should be taken not to be too dogmatic in attempting the localisation of cerebral injuries from the symptoms during life.

EXAMINATION OF BODIES FOUND DEAD.

When called to a case of sudden death everything likely to point to the cause of death should be taken notice of. The place at which the body was found, the attitude of the body and its position, the state of the clothing, the relative position of objects surrounding it, and the surface or soil upon which the body is lying.

In making a post-mortem examinination for medico-legal purposes every cavity and important organ must be carefully examined. The seat of injury should be inspected first, in order that the contents of the blood-vessels may not be disturbed by the examination of other parts.

MODES OF SUDDEN DEATH.

Death may occur in three modes—viz., syncope, asphyxia, and coma.

Syncope, or sudden cessation of the heart's action, may result from—1. Deficiency of blood, due to hæmorrhage—*i.e.*, death by *anæmia*, the heart ceasing to beat, since it has no blood to propel

2. The effects of certain diseases and poisons—*i.e.*, death by asthenia, the heart's action ceasing since its muscular walls are paralysed. The nervous system is sometimes primarily affected in death by asthenia, as when sudden death follows strong mental emotion. The post-mortem signs are—a normal quantity of blood in the heart in death by asthenia; when death is due to anæmia the heart may be almost empty. In death by asthenia the blood is merely arrested in its course, and this fluid is therefore found in the large veins and arteries. There is no engorgement of the brain and lungs.

Asphyxia, or *Apnœa*, death from obstruction to the lungs, results from—1. Certain diseases of the lungs, as bronchitis and pneumonia. 2. Mechanical obstruction to respiration, drowning, strangulation, hanging, &c. Autopsy reveals engorgement of the pulmonary artery, right cavities of the heart, and the venæ cavæ. whilst the left side of the heart, the aorta, and the pulmonary veins are comparatively empty.

Coma.—Death due to some cerebral mischief, and resulting from apoplexy, fracture of the cranial bones, and cerebral compression. The post-mortem signs are congestion of the membranes and substance of the brain and lungs, more or less blood being found in the heart's cavities, especially in the right.

SIGNS OF DEATH

These are divided into trivial and inconclusive, and into important and conclusive. To the first belong—1. *Cessation of the circulation and respiration*, the stethoscope revealing no sound, 2. *The state of the eye*, tenacious glairy mucus on the conjunctiva (loss of translucency) with a collapsed and wrinkled cornea; 3. *Absence of sense and motion;* these, however, may occur in cases of suspended animation; 4. *The facies Hippocratica*—an unsafe sign, frequently absent in sudden death, and present in the dying as well as in the dead. 5. *The state of the skin;* pallor from absence of circulation, livid discolorations from subsidence of the blood, and loss of elasticity, have been mentioned among the signs of death. 6. *Extinction of muscular irritability*, the muscle making no response to electrical currents.

The signs given above afford no means of establishing how long life has been extinct. The following do:

1. *Extinction of Animal Heat;* the average internal temperature of the body is from 98° to 100° F.; after death, the time occupied in cooling is from fifteen to twenty hours, but it is subject to modification according to the kind of death, the absence or presence of clothing on the body, and the surrounding temperature. The body may roughly be said to be *quite cold* in about *twelve hours.*

2. *Hypostasis* or *Post-mortem Staining* depends upon the settling down or gravitation of the blood, during the cooling of the body, to the most dependent parts of the body. It is a certain and co-

clusive sign of death, and is seen in all forms of death—even when it is due to hæmorrhage—although its extent is not so marked. In *Cadaveric lividity*, or *Hypostasis*, the hypostatic marks begin to form in from eight to ten hours after death, and increase until the advent of putrefaction. Hypostasis is known from an ecchymosis or a bruise by making an incision into the part; in the case of cadaveric lividity, a few small bloody points of divided arteries will be seen; in the ecchymosis coagula. Hypostasis must also be distinguished from congestion of the brain or lungs, or inflammation of the intestines. If the intestinal convolutions are drawn out, the inflammatory redness is seen to be continuous, whereas hypostasis is interrupted.

3. *Cadaveric Rigidity and Rigor Mortis.*—The muscles, for some period after death, contract upon stimulation. Upon the cessation of this irritability, which rarely exceeds two hours, rigidity sets in, and it in every case is precursory to putrefaction. It results from the coagulation of the muscle-fibrin. It begins in the muscles of the lower jaw and the neck, extending thence to those of the face, front of neck, upper extremities, and chest, and finally to the lower limbs. It lasts from sixteen to twenty hours or more. In those dying from an accident and in health, it may not appear until ten to twenty-four hours, and may persist for three or four days. It has never been seen in the fœtus, although it has occurred in the new-born child. It sets in rapidly in lingering diseases, or when violent exertion has been undergone, and may only remain for two or three hours. It is often protracted in cases of strychnin poisoning. It must not be confounded with cadaveric spasm or the *death-clutch*; in rigor mortis any substance held by the hands is easily removable, but in the death-clutch the contrary is the case.

4. *Putrefaction.*—In from one to three days after death a greenish-blue discoloration of the abdomen appears, which gradually increases, becoming darker and more general; simultaneously a strong putrefactive odour is developed, the thorax and abdomen becoming distended with gas, and the epidermis peeling off. The muscles now become pulpy, and appear of a dark-greenish colour, the whole body finally becoming converted into a soft, semi-fluid mass. The first putrefactive change is seen in the trachea; the uterus resists putrefaction the longest. Putrefactive changes may be modified by the fat or lean condition of the body, the temperature of the air (putrefaction occurs far more rapidly in summer than in winter), the period, locality, mode of interment, and the age. Bodies lying in water become the seat of putrefactive changes more slowly than those remaining in air.

Saponification.—*Adipocere.*—This change is a modification of the putrefactive process, and takes place in bodies which are very fat and have remained in water or in a moist soil for a long period, sometimes for years. It appears, however, that under favourable conditions, as in running water, a body may partially be converted into adipocere in from four to five or six weeks. The substance,

adipocere, is formed by the fat of the tissues uniting with the ammonia given off by decomposition; it is a peculiar unctuous, soapy substance, with an odour of decayed cheese, the name being derived from *adeps*, lard, and *cera*, wax. In fact, in appearance it is somewhat between lard and wax, and is sometimes white and at other times yellowish-brown in colour. Some specimens appear to consist of an ammoniacal soap, making a lather with water; others contain calcium as a base, which is combined with oleic, stearic, perhaps palmitic, and some say margaric, acid, as oleate of calcium or ammonium, and so on. It has been stated to contain potash and oxide of iron.

DEATH BY DROWNING.

In this mode of death, the breathing may be arrested by watery or semi-fluid substances, sand, mud, &c. The fluid in the majority of cases produces spasm of the glottis, but it occasionally acts mechanically by entering the air-cells of the lung. The post-mortem appearances are those which are generally present in death by asphyxia, with the addition of those which are peculiar to death by drowning—viz., abrasion of the fingers, with sand or mud under the nails, aquatic plants grasped in the hand; water in greater or less quantity in the stomach; froth in the nostrils and the mouth; the air passages containing fluid, froth, mud, or sand; contraction and retraction of the penis and the cutis anserina (goose-skin). Retraction of the penis is considered a very important sign.

Death may ensue if the face only is under water. This has happened in the case of a man in a fit of drunkenness, falling into and remaining face foremost in a very small pool of water, caused by the print of a horse's hoof.

In the swimmer death may ensue from exhaustion, and less distinct marks of asphyxia be presented.

A man jumping from a height may perish by concussion by striking against some solid body, or even against the water; or by falling upon the chest and pit of the stomach die from immediate shock. Cold or excitement may cause apoplexy and heart disease, and lead to sudden death, as sometimes happens to persons bathing in very cold and shallow water.

Death by drowning may ensue from asphyxia, exhaustion, shock, syncope, or apoplexy, or partly from asphyxia, and partly from other causes; the mixed cases being by far the most usual.

The appearance of the body will of necessity vary with the cause and manner of the death in each particular case.

The lungs in death by drowning are distended, overlap the heart, and they feel peculiarly spongy; in them and in the windpipe also is contained a quantity of frothy fluid resembling soap-suds, and which is produced by the violent attempts at breathing during the act of dying. This frothy liquid must not be confounded with the viscid mucus from the bronchi present in bronchitis.

An important sign of drowning is afforded by the presence of vomited matters in the bronchi and trachea.

Resuscitation of the Drowned: the body should be stripped as rapidly as possible, and the clothes rolled up in the form of a bolster, and placed under the pit of the stomach; the body should be turned on the face with the head downwards, so as to allow the escape of fluid by the mouth. The operator, with both hands, presses on the back of the patient a few times in order to expel any fluid from the lungs and trachea. The body is now quickly turned over on the back, the bolster being placed in the small of the back, and the operator, having his hands on each side of the thorax, imitates the acts of respiration. The hands should be placed over the head, the tongue being drawn out to one side of the mouth, so as to afford as much entrance of air as possible by this channel. When the respiration is restored sufficiently the patient should be given a hot bath, being subsequently dried and placed in a blanket, and hot tea or coffee administered to him.

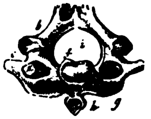
DEATH BY SUFFOCATION.

This includes all cases of asphyxia which are produced by direct pressure on the trachea, with the exception of drowning. It may be caused through the mouth and nostrils being stopped by accident or by force; by mechanical pressure on the chest; by closure of the glottis; by vapours, as the vapour of charcoal (carbonic anhydride and carbonic oxide); by the bursting of abscesses into the windpipe, or vomited matters obstructing the windpipe. Poisoning by strychnine, conium, &c., may produce death by suffocation by causing contraction of the chest-muscles. In some cases of death by suffocation no signs of external injury are present. Signs of death by suffocation are not always well marked, but they are those of death by apnœa (asphyxia). The lips may be livid, the face pale or violet, the eyes congested. Great stress has been laid upon the presence of dark-coloured punctiform sub-pleural ecchymoses. The blood is very fluid and dark, and the stomach and other intestines often much congested.

DEATH BY HANGING.

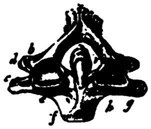
In hanging, death occurs by apnœa or from dislocation or fracture of the cervical vertebræ or the odontoid process of the axis through the force of the fall. Sensibility is soon lost, and death is complete in a few minutes. The external appearances are in general those of death by suffocation. The countenance may be livid and distorted, the eyes staring, bloody froth being found about the nostrils and the mouth. In other cases the countenance has been found placid, and no lividity or distortion has been observed. Escape of fæces or urine may occur, but the emission of semen, so popularly believed, is very rare. The mark on the neck indicates the course of the cord, which is straight round the neck in strangulation, but is oblique in hanging. The muscles and ligaments of the trachea in judicial hanging may be considerably injured. Entire absence of injury to the soft parts about the neck has been observed in ordinary suicidal hanging. The mark of the cord is a *purely cadaveric phenomenon*, and is not an indication of hanging; it may be produced some hours after death.

FIG. 70.



Axis, or Vertebra Dentata (lower surface). *a.* Spinous process. *b.* Lamina. *c.* Notch. *d.* Inferior articular process. *i.* Foramen medullare. *f.* The body. *h.* Processus dentatus. *g.* Root of the transverse process.

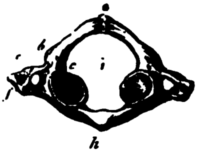
FIG. 71.



Axis (upper surface). *a.* Spinous process. *b.* Lamina. *c.* Anterior root of the transverse process. *d.* Posterior root of the transverse process. *e.* Superior articular process. *f.* The body, from which springs the processus dentatus (odontoid process). *g.* Anterior root of the transverse process. *h.* Surface conducting to the notch. *i.* Foramen medullare.

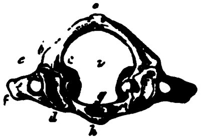
In reference to judicial hanging, the use of the "long drop" (the Irish method) is considered by far the most humane, since it ensures the rupture of the spinal column by the fall. The fracture of this column is best effected instantaneously by placing the knot under the chin and allowing a fall of from ten to fourteen feet. The celebrated Louis found that in cases of rapid death at executions by hanging, the executioner gave to the body of the criminal a violent rotatory motion at the moment it was turned off. Thus

FIG. 72.



The Atlas (viewed from below). *a* Tubercle representing the spinous process. The other letters indicate the corresponding or similar structures as in fig. 73.

FIG. 73.

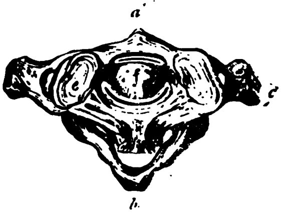


Atlas (upper surface). *h.* Anterior margin of the ring of the atlas. *g.* Articular surface for the play of the odontoid process of the second vertebra or axis. *d.* Superior articular process, right side. *f.* Transverse process, in its base may be seen the foramen for the passage of the vertebral artery. *c.* Points to the tubercles to which the transverse ligament is attached. *e.* Points to the groove connecting the notch and vertebral foramen. *b.* The commencement of the posterior part of the ring of the atlas. *i.* Is placed in the anterior part of the foramen for the spinal marrow, and a short way behind the situation of the ligament.

displacement of the odontoid (tooth-like) process of the axis (second cervical vertebra) ensued, the spinal cord or marrow being suddenly compressed. Figs. 70–73 show the structure of the atlas and axis respectively; and in fig. 74 are shown the synovial capsules and the transverse ligament immediately behind the odontoid process.

When such force is employed as to break the transverse and other ligaments, or to cause fracture of the odontoid process, not only may the phrenic and other respiratory nerves become paralysed, but also rupture of the carotid and vertebral arteries may take place, and the medulla oblongata, the so-called *vital knot* (the centre for respiration, circulation, and deglutition), can hardly escape being severely and fatally injured.

FIG. 74.



Occipito-atlantoid articulation. *a.* Anterior tubercle of the atlas. *b.* Posterior. *c, c.* Transverse processes. *e, e.* Articular cavities for receiving the condyles of the occipital bone. *f.* Summit of the odontoid process *in situ.* The section shows the synovial capsules before and behind the odontoid process, and also the position of the transverse ligament immediately behind the odontoid process.

DEATH BY STRANGULATION.

In this case the body is not suspended. It may be caused by a ligature carried circularly round the neck. Death is said to be caused by *throttling* when it has resulted from the constant pressure of the fingers on the throat. Hanging may be either suicidal or accidental, but usually throttling and strangulation are homicidal.

WOUNDS AND MECHANICAL INJURIES.

A wound has been defined as "a breach of continuity in the structures of the body, whether external or internal, suddenly occasioned by mechanical violence." In law, the true skin must be broken. Wounds may be dangerous from shock or from hæmorrhage, or from being followed by erysipelas, and pyæmia, or from want of skill on the part of the medical attendant, or negligence of the patient. The answer to such a question as, "Is the wound dangerous to life?" demands a very guarded answer.

Scalds are caused by hot fluids; burns by flames, by solids highly heated, or by very cold solids, as with solid carbonic acid.

Severe burns may cause death from shock, from internal hæmorrhage, or from ulceration of the duodenum. When a burn has been inflicted during life a bulla or blister containing serum may form over an inflamed surface; after death any bleb that may be present contains no fluid. According to Dupuytren there are the following degrees of burns:—1. Superficial inflammation; redness without blistering. 2. Acute inflammation; with the formation of vesicles. 3. Destruction of the superficial layer of the true skin. 4. Destruction of the skin and subcutaneous cellular tissue. 5. Entire carbonisation of the parts.

Contused Wounds and Injuries unaccompanied by Solution of Continuity.—A blow inflicted with a blunt instrument produces a bruise or *ecchymosis*. A bruise is distinguished from a post-mortem stain or cadaveric lividity by the fact that the former is not confined to the cellular membrane, but involves the substance of the true skin. In a bruise inflicted during life the skin is discoloured and dark, and thickened by the infiltration of blood. Up to two hours after death signs resembling bruises caused during life may result from blows.

On cutting into a bruise there is considerable effusion of blood, the clots are large, and there is a strong presumption that it was inflicted during life. When, however, a post-mortem stain is cut into no clot is observed, but there are merely a few bleeding points due to the division of capillaries.

Incised Wounds and Wounds accompanied by Solution of Continuity.—Incised, punctured, and lacerated wounds are included under this category. In a recent incised wound, inflicted during life, there is copious hæmorrhage, the cellular tissue is filled with blood, the edges of the wound are everted, and coagula found between the lips of the wound. In a wound inflicted after death there is no retraction of the muscles and skin, a small quantity of liquid venous blood is effused, the edges of the wound are not injected and not everted; but a wound inflicted immediately after death may present all the appearances of one inflicted during life.

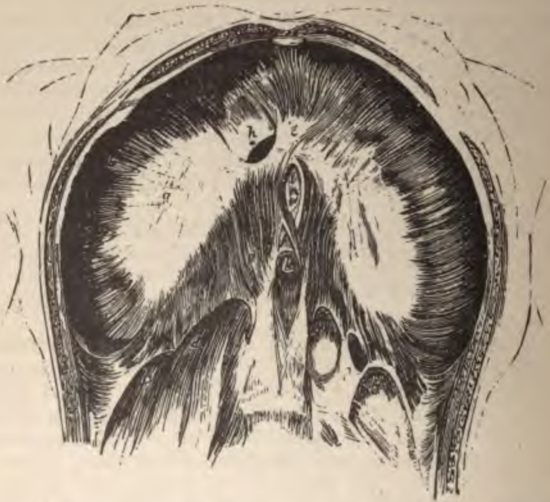
Lacerated wounds combine the characters of incised and contused wounds, and in them healing takes place by suppuration. They are accompanied by less discoloration than contused wounds, and by less hæmorrhage than incised wounds.

Punctured wounds stand intermediate between incised and lacerated. They are more dangerous than incised wounds, cause little external hæmorrhage, and heal usually by suppuration, but death may result from internal hæmorrhage.

Gunshot Wounds.—These may be either contused when the projectile does not penetrate, or lacerated when it enters or traverses the body. A larger opening is caused by round balls than by conical ones. Small shot, if fired a very little way from the body, make one large, ragged opening. In every case it is important to preserve the contents of all gunshot wounds, as they may prove very useful in evidence. Unlike a punctured wound the gunshot wound, as its depth increases, becomes larger. When the bullet traverses the body two apertures will be observed; that of entrance is round and clean, whilst that of exit is less regular and jagged, and it is invariably *smaller* than that of entrance. When the weapon has been fired close to the body, unburnt powder may be found imbedded in the skin surrounding the wound.

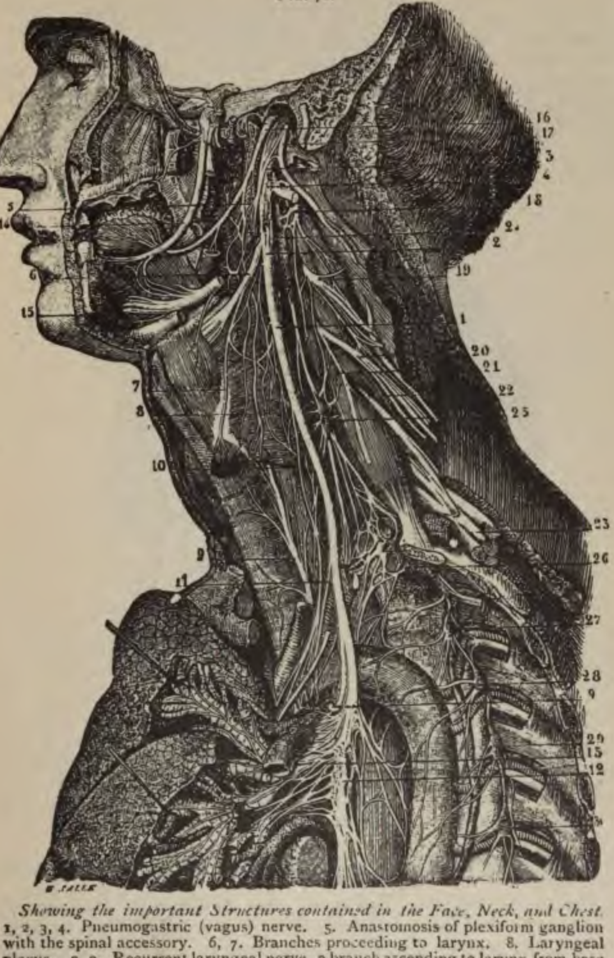
As to the time when a shot was fired, some approximate conclusions may be drawn as follows:—When gunpowder is exploded, one of the products is sulphide of potassium, and by exposure to air some part becomes converted into sulphate of potassium. If a finger introduced into the gun-barrel is blackened, and if the barrel is free from rust or crystals of protosulphate of iron; if the solution (made by washing out the gun-barrel with distilled water and the washings filtered) is of a yellow colour, smelling strongly of sulphuretted hydrogen, or yielding a black precipitate with lead acetate, the weapon has not been discharged more than two hours. If the colour of the interior of the barrel is less dark, but *contains* neither crystals of ferrous sulphate nor rust, but the

FIG. 75.



The Diaphragm, or Midriff (the great muscle of inspiration). *a*. Cordiform, or heart-shaped tendon of right side. *b*. Fleshy fibres of the great muscle of the diaphragm. *c*, *d*. Ligamenta arcuata of the right side. *e*. Fleshy fibres of the right crus. *f*. Decussation of the crura. *g*. Central portion of the cordiform tendon. *h*. Opening for the passage of the inferior vena cava. *k*. Section of the aorta as it passes between the crura and behind the diaphragm, and upon the vertebral column. *l*. Œsophageal opening of the diaphragm.

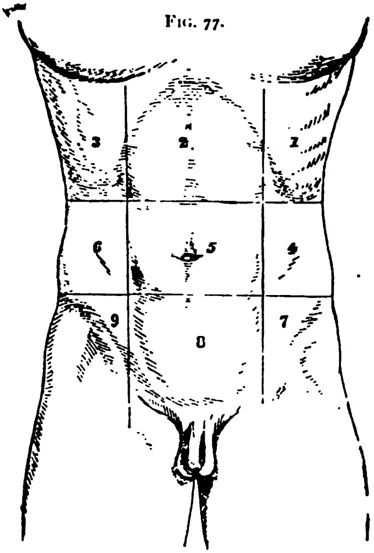
FIG. 76.



Showing the important Structures contained in the Face, Neck, and Chest. 1, 2, 3, 4. Pneumogastric (vagus) nerve. 5. Anastomosis of plexiform ganglion with the spinal accessory. 6, 7. Branches proceeding to larynx. 8. Laryngeal plexus. 9, 9. Recurrent laryngeal nerve, a branch ascending to larynx from base of the neck. 10, 11. Cardiac branches going to the heart. 12, 13. Pulmonary plexus. 14. Lingual nerve. 15. Terminal portion of the great hypoglossal. 16. Glosso-pharyngeal nerve. 17. Spinal accessory nerve of Willis. 18. Cervical nerve of second pair of spinal nerves. 19. Third cervical pair. 20, 21, 22. Spinal nerves. 23, 26, 27, 28. Pairs of cervical nerves uniting with first dorsal to form brachial plexus. 24. Superior cervical ganglion of great sympathetic. 25. Middle cervical ganglion. 26. Inferior cervical ganglion. 27 to 30. Dorsal ganglion.

solution (made as above mentioned) shows traces of sulphuric acid when tested with chloride of barium, the period that has elapsed is more than two but less than twenty-four hours. If many spots of rust are observable in the interior, and if the solution shows indications of iron when tested by ferricyanide of potassium, at least twenty-four hours, perhaps six days, have intervened. If the rust is in greater abundance, the solution no longer yielding any iron reaction, at least ten days, and perhaps fifty days, have passed since the discharge of the weapon.

FIG. 77.

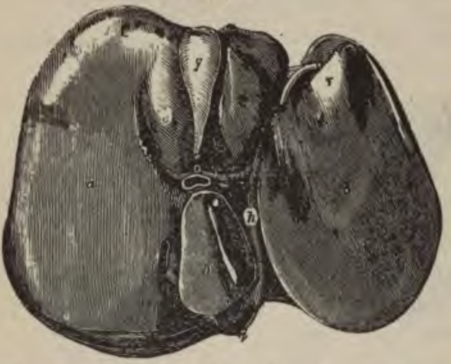


Imaginary lines drawn upon the surface of the abdomen, dividing it into regions. These were, no doubt, devised by reason of the absence of any characteristic eminences or depressions upon this extensive surface, principally attributable to the absence of any skeleton, osseous or cartilaginous. 1. Left hypochondriac region. 2. Epigastric. 3. Right hypochondriac. 4. Left lumbar. 5. Umbilical. 6. Right lumbar. 7. Left iliac. 8. Hypogastric. 9. Right iliac.

Wounds of various parts of the Body.—*Of the Head.*—Erysipelatous or diffuse inflammation is specially liable to follow wounds of the scalp Fracture of the base of the skull may result from a severe blow upon the vertex. Blows or violent shocks frequently cause concussion of the brain, the symptoms following immediately on the accident. Depressed bone or effused blood and serum may lead to compression of the brain, the symptoms coming on suddenly or gradually. Very slight wounds may produce very slight symptoms, or very severe ones. An injury may be received to the head, recovery take place from the first effects, and then death ensue with symptoms of compression from internal hæmorrhage. Inflammation usually comes on after variable periods, and may result from injuries to the brain, the scalp, the orbit, and the ear.

Injuries to the Spinal Cord may be due to concussion, compression, or to wounds. When the cord is the seat of serious injury, a fatal result occurs immediately or very rapidly. When the injury is in the dorsal or lumbar region there is loss of sensation and of power below the seat of mischief, the fæces escaping and the urine being retained. When the upper part of the cord is injured, death may result from paralysis of the muscles of respiration.

FIG. 78.



Shows the concave surface of the Liver (that surface which rests on the stomach and colon). *a.* The right lobe. *b.* The left lobe. *c.* Lobulus quadratus; this lobe or lobule separates the gall-bladder, *g*, from the obliterated umbilical vein, *r*, which, after birth, becomes the round ligament of the liver. *d.* Lobus or lobulus Spigelii; this separates the fossa for the reception of the vena cava inferior and the vein itself, *i*, as it passes behind the liver and through the diaphragm, from the fossa, in which is lodged the obliterated ductus venosus. *e* is perhaps a little too high up; it is meant to point to the lobulus caudatus, a small portion of the liver which connects the great lobe to the lobule of Spigel. *f.* The hepatic artery, dividing into its right and left branches: close to it is the vena portæ, cut across. The sulcus, into which these vessels are passing, is the transverse hepatic sulcus or sinus of the porta, and the lobes bounding it receive also the names of anterior and posterior portal eminences. *r.* The remains of the umbilical vein. *h.* The remains of the ductus venosus.

Of the Throat.—Division of the carotid artery is fatal, and that of the internal jugular vein excessively dangerous. Wounds of the larynx and trachea are not usually dangerous. The important structures contained in the neck and chest are shown in Fig. 76.

Wounds of the Lungs are followed by hæmorrhage, and very frequently by inflammation.

Of the Face lead to great disfigurement; there is a risk of the brain becoming injured.

Of the Chest.—Incised wounds of the chest walls do not present much danger; severe blows, however, by causing fracture of the bones and internal injuries, frequently prove fatal.

Of the Pulmonary Artery and Aorta are fatal.

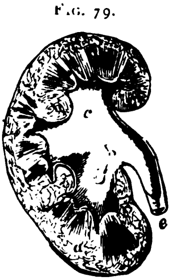
Of the Thoracic Duct and Œsophagus are very rare.

Of the Heart.—Penetrating wounds prove fatal in consequence of the hæmorrhage they produce; those of the base more speedily fatal than those of the apex.

Of the Diaphragm (Fig. 75).—Usually are dangerous from hernia of the stomach.

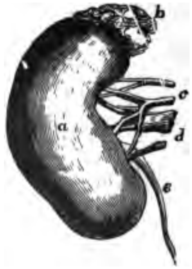
Of the Abdomen.—Wounds of the abdominal walls may prove dangerous from division of the epigastric artery; ventral hernia may occur. Fig. 77 shows the various regions of the abdomen, for the contents of which reference must be made to the text-books on anatomy.

FIG. 79.



A vertical section of the Kidney. *a.* The cortical substance. *b*, *c*. The interior or mucous surface of the calices, infundibula, and pelvis of the ureters, all these tubes having been laid open by the section. *e.* The ureter cut across. *d*, *d*, *d*. The mammillary substance and the eminences in which they terminate.

FIG. 80.



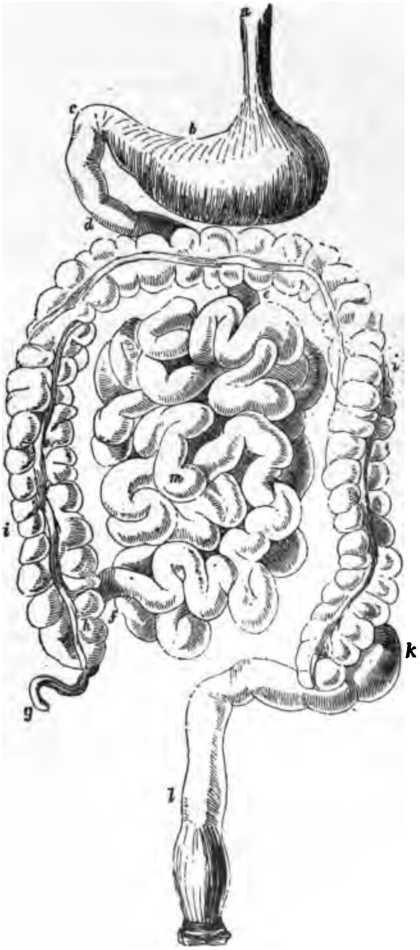
The Right Kidney and corresponding Supra-renal Capsule (anterior surface). *a.* The kidney. *b.* The supra-renal capsule. *c.* The chief branch of the renal artery; in this instance the renal artery appears to have entered the fissure of the kidney by three branches, as shown in the figure. *d.* The renal or emulgent vein. *e.* The ureter. The direction of the duct called ureter and the position of its pelvis or dilated origin, when properly attended to, will enable one kidney to be distinguished from the other although these organs have been removed from all their connexions. The pelvis of the ureter is placed behind the other vessels.

Of the Liver (Fig. 78).—The large vessels of this organ may be divided. Wounds of the gall-bladder induce effusion of the bile and inflammation of the peritoneum.

Of the Stomach (Fig. 81).—These may prove fatal by shock, by hæmorrhage, or by inflammation.

Of the Intestines (Fig. 81).—These may prove fatal in the same way as do those of the stomach. They are more dangerous in the small intestines than in the large.

FIG. 81.



Alimentary Canal from the lower end of the Gullet to the Rectum. *a.* The gullet where it joins the stomach. *b.* The stomach; the letter is placed on the small curvature of the organ. *c.* The pyloric end of the stomach and the commencement of the duodenum. *d.* Duodenum. *e.* Commencement of the jejunum. *f.* The termination of the small intestine (ileum) in the large. *m.* Convolutions of the tract of the small intestine. *g.* Appendix vermiformis. *h.* The cæcum. *i.* The ascending colon. *i, i.* The descending colon. *k.* The sigmoid flexure of the colon. *l.* The rectum.

Of the Spleen.—Deep wounds prove fatal in consequence of hæmorrhage.

Of the Kidneys (Figs. 79 and 80).—These may prove fatal by hæmorrhage, inflammation, or extravasation of urine.

Of the Bladder.—May prove dangerous from extravasation of urine.

Of the Genital Organs.—Fatal hæmorrhage may follow removal of the penis; if hæmorrhage does not occur, the removal of this organ is not dangerous. Removal of the testicles may cause a fatal issue from shock to the nervous system. Wounds of the spermatic cord may lead to dangerous hæmorrhage. Wounds to the vulva of women are exceedingly dangerous in consequence of the large plexus of veins contained in them and which are destitute of valves.

DEATH FROM STARVATION.

Very little is absolutely known as to the length of time necessary to cause death by starvation, but it has been proved that life may be prolonged for some considerable time without food, providing water is allowed. The symptoms may be abdominal pain, which pressure relieves, redness of the eyes, intense thirst, progressive emaciation, dry dusky skin, exhaustion, delirium, and death. The morbid appearances are the following: Marked emaciation and anæmia, the skin dry and shrivelled, the muscles small, soft, and devoid of fat, a peculiar fœtid odour from the body, the liver small, and the gall-bladder distended with bile. The heart and kidneys are destitute of fat, and the internal organs shrivelled and bloodless. The stomach is quite healthy although bile-stained; at other times it may be collapsed, empty, and contracted, and attended with more or less ulceration of the mucous membrane. The intestines are also contracted, thin, and empty, and shrunken to such a degree that the canal is almost obliterated.

In the absence of any disease productive of extreme emaciation, such a state of body affords a strong presumption of death by starvation.

DEATH FROM LIGHTNING.

The signs of death by this agency must necessarily vary greatly. In some cases there are no signs; in others the body may be most curiously marked. The presence of a storm at the time the deaths were alleged to have taken place, and other accompanying circumstances, will help to assign the cause of death.

The clothes have been found torn from the body with hardly any injury to the individual. The wounds on the body may be sometimes lacerated, at other times punctured. Steel articles worn at the time may become magnetic. Occasionally persons destroyed by lightning have been found exactly in the same position that they occupied during life.

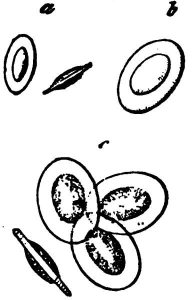
DETECTION OF BLOOD-STAINS.

Red stains on articles of clothing, on cutting instruments, on floors, and furniture, may require examination; or the character of watery solutions may require to be determined; the medical jurist may also be asked to distinguish the blood of man from that of the lower animal.

Naked-eye Appearances. — Blood-stains on a dark-coloured material in daylight may be easily overlooked, but may be readily observed by bringing a lighted candle near the cloth. When recent, blood-spots are of a bright-red colour, if arterial; of a purple hue, if venous. Exposure to the air renders the latter brighter. When a few hours have elapsed, blood-stains acquire a reddish-brown tint, and this colour they maintain for years.

Microscope.—Blood may be known by the presence of the characteristic blood corpuscles. The shape in man of the blood-cells is round (Fig. 82); in birds, batrachia, fishes (Fig. 83), it is oval or elliptical.

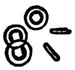
Fig. 83.



Elliptic Corpuscles of the Blood in birds, batrachia, and fishes. *a.* Corpuscles of the blood in the domestic fowl, seen in profile. *b.* Corpuscles of the blood in the frog. *c.* Corpuscles of the blood in a fish of the shark kind. Magnified nearly 400 diameters.

Action of Water. — Blood-stains dissolve rapidly when the material containing them is placed in cold water, and they form a bright-red solution. *Rust* is not soluble in water.

Fig. 82.



Human blood corpuscles, magnified nearly 400 times in diameter.

Heat.—To remove a blood-stain from a knife, if the metal is heated, the blood peels off, which rust will not do. If the metal on which is the blood-stain is exposed to the air for a long period and rust is mixed with the blood, the test will be valueless. The solution of blood in water is coagulated by heat, its colour is completely destroyed, and a flocculent muddy-brown precipitate forms.

Caustic Potash.—The coagulum formed by boiling the solution of blood in water is soluble in caustic potash, and the so-prepared solution is then greenish by transmitted, and red by reflected light.

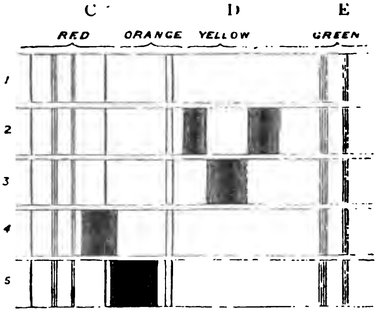
Nitric Acid —On the addition of nitric acid to a watery solution of blood, a whitish-grey precipitate is formed.

Guaiacum.—On adding fresh tincture of guaiacum to the blood solution, a reddish-white precipitate of the guaiacum resin results; and on the addition to this of an ethereal solution of peroxide of hydrogen (ozonised ether), a rich sapphire-blue colour is *developed.* This test is extremely delicate, and will discover one drop of blood in six ounces of water. This test is directly applicable to stains on linen.

Hæmin Test.—When this test succeeds it is quite conclusive o the presence of blood. To apply it, the blood solution evaporated to dryness is used, or some dried blood from a stain, or the precipitate caused by acetate of zinc or by tannin. To the dried portion of blood is added glacial acetic acid, with a crystal of chloride of sodium, and the whole is carefully boiled over a spirit-lamp; on cooling, the mass shows (microscopically) intermingled with crystals of acetate and chloride of sodium, very large numbers of dark-brown rhombic prisms of hæmin. These are known as *Teichmann's Crystals,* and consist of a compound of hydrochloric acid with hæmatin, which is one of the products of the decomposition of hæmaglobin.

Spectroscope.—Solutions of the colouring matter of the blood when of the right degree of concentration show in the spectrum two dark absorption bands in the green, between the lines D and E. The first absorption band—*i.e.*, from the left—is narrower and defined more sharply than the second, a green interspace separating the two. The spectrum with the two absorption bands (2, Fig. 84) is that of oxidised hæmaglobin. Upon the addition of a reducing agent as sodium or ammonium sulphide or a solution of protosulphate of iron (to which tartaric acid has been added to prevent precipitation by alkalies) these two bands disappear, and are replaced by only one band. This is dark in the middle, the edges being washed out, and it occupies what was the green interspace between the two bands of oxidised hæmaglobin. This is the spectrum of reduced hæmaglobin (3, Fig. 84). Upon shaking the solution with air, it becomes again reoxidised and presents the spectrum with the two lines as before. A

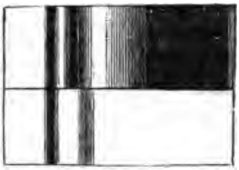
FIG. 84.



1. Solar spectrum. 2. Oxidised hæmaglobin. 3. Reduced hæmaglobin. 4. Hæmaglobin decomposed by acids. 5. Hæmaglobin decomposed by alkalies.

red solution having the above-mentioned characters can only be a solution of blood-colouring matter. Red solutions, as of carmine and alkanet root in solution of alum (Fig. 85), present spectra which, upon a careless glance, might be mistaken for solutions of hæmaglobin. The bands of these, however, do not occupy the same position in the spectrum, and they are not capable of reduction and reoxidation as already described. The reduction test should therefore always be resorted to in determining the nature of a suspected blood-stain. By long exposure to air, or under the influence of alkalies and acids, hæmaglobin becomes decomposed into a proteid substance, and *hæmatin* (a brown colouring matter). Upon adding acetic acid to a solution of hæmaglobin, the solution becomes brown, hæmatin being formed; now if the turbid fluid is shaken with ether, a clear ethereal solution is formed, and this, when examined with the spectroscope, exhibits a characteristic absorption band which coincides nearly with Frauenhofer's line C, in the confines of the orange and red (4, Fig. 84). In a similar manner, hæmaglobin is split up by alkalies into a proteid substance and hæmatin; but in this case the hæmatin line is broader, and its position lower down the spectrum nearer to the line D, the blue end of the spectrum being much obscured (5, Fig. 84). This alkaline hæmatin can be reduced like hæmaglobin, and be again oxidised. In the spectrum of reduced hæmatin are observed two well-defined absorption bands like those of oxy-hæmaglobin, but their position is lower down, closer to the blue. In blood-colouring matter after exposure to the air for some time, but which has not been changed completely into hæmatin, is observed a spectrum which shows three bands, one nearly identical with the hæmatin band, and the other two like the bands of oxy-hæmaglobin. An intermediate transformation of the hæmaglobin into methhæmaglobin is here supposed to be indicated.

FIG. 85.



Spectrum of Fresh Blood and of Alkanet Root in Alum. The figure shows two black absorption bands in the upper part of green section of spectrum. The upper of the two spectra shows appearances due to solution of fresh blood; the lower spectrum is that of alkanet root in alum, the nearest colouring matter to that of fresh blood solution.

Iron-moulds on linen, and spots of lemon-juice on a knife, have been mistaken for blood stains.

Broadly speaking, then, the spectrum of the colouring matter of the blood shows the presence of two dark absorption bands, the situation of one being at the junction of the yellow with the green rays, and that of the other in the middle of the green rays of the spectrum.

Menstrual blood cannot be distinguished from human blood which has flowed from a wound.

Liquor ammoniæ never turns blood-stains green or crimson, as is very often the case when this reagent it added to fruit juice; with blood-solution it merely produces a slight *heightening* of the colour.

EXAMINATION OF HAIRS AND FIBRES.

Hairs from men or other animals, or portions of some fabric, are often contained in blood-stains, seminal stains, and wounds, or they may be found attached to a weapon, and it becomes a matter of great importance to recognise the source from which they are derived. It is sometimes impossible to say what hair or fibre is present, but it is an easy matter to distinguish human hairs from those of other animals, and to become familiar with the fibres of wool, silk, linen, and cotton. A magnifying power of from 200 to 300 diameters will be found sufficient in ordinary cases for the identification of hairs and fibres.

Cotton presents flattened bands of a twisted or spiral structure.

Linen fibres are rectilinear, having jointed markings at unequal distances, with fibres tapering to a point.

Silk is cylindrical, is almost free from any markings, and refracts light very powerfully.

Wool is a variety of hair; its fibres are irregular and of unequal thickness.

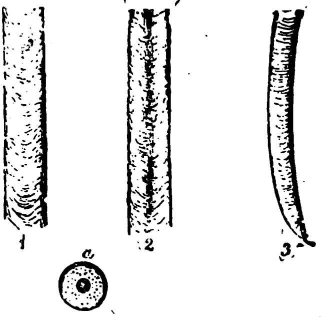
Human hairs (Fig. 86) have an extremely thin cortical substance, and this is more marked by fine transverse lines than in any other mammal.

All hairs consist of a cortical and medullary substance, enveloped in an imbricated cuticle. The medullary substance may be absent when the hair is soft and young, and the entire hair is fibrous in appearance. The hairs of the head are generally truncated, or split at the free end, those of the body being usually pointed.

In Fig. 86, 1 shows the hair of a child with the linear markings on the cortical portion. 2 shows the hair of an adult. (In each case magnified 300 diameters.) The lines are seen equally on the cortical portions, the dark shading in the centre representing the situation of cells, by which the centre of the medullary portion is traversed. At *a* is seen a transverse section of the hair, in which is shown the cortical and medullary portion, and the air cells in the centre of the cylinder. Upon measurement these hairs are found to have a diameter of $\frac{1}{360}$th of an inch. Some human *hairs* do not exceed the $\frac{1}{600}$th of an inch. 3 shows the pointed *extremity of the hair* of the eyebrow. The hair of the eyebrows and the eyelashes are thicker and coarser than those of the head, and are opaque, except close to the point, at which they become transparent.

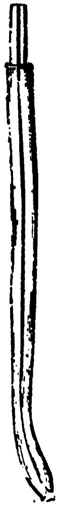
In a microscopical examination of hairs observation should be made as to whether they are of the same or of different colours or sizes, whether they are cut at both ends or pointed at one end, and whether the bulb or sheath in which they grew still remains attached to them.

FIG. 86.



Human hair. 1. The hair of a child (magnified 300 diameters). 2. Hair of an adult (magnified 300 diameters). 3. Pointed extremity of the hair of the eyebrow. *a*. Transverse section of the hair, showing the cortical and medullary portion, and air-cells in the centre of the cylinder.

FIG. 87.



Human hair with the tubular sheath, as torn out by force. (Magnified 70 diameters.)

In Fig. 87, 4 shows the sheath of the hair with the hair issuing from it. This state of the hair is observed when it has been torn violently from the skin. The medullary structure frequently retains marks of violent treatment, and thus the microscope may show indications that a hair has been indented, cut, or bruised at either or both ends.

The hair of the lower animals differs in many particulars from that of man. In some animals the fibrous and cellular structure are combined, whilst in many the hair is entirely cellular (Fig. 88).

The hairs of animals are, generally speaking, coarser, thicker, shorter, and less transparent than those of the human subject.

The hair of some animals, as that of the cow, horse, and the

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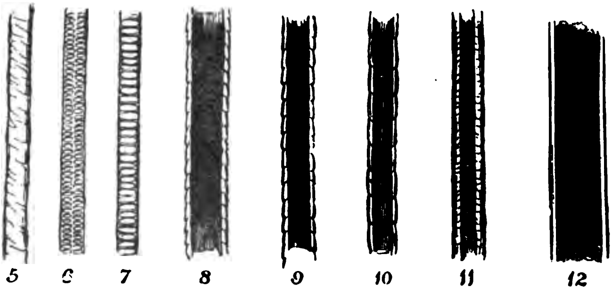
deer may be at once recognized by the eye or by a pocket lens; but the hair of some dogs—viz., the spaniel and sky terrier—bears a close resemblance to that of man. It is silky and long, but the linear markings on the cortical portion are not so fine or so numerous.

In Fig. 88 the microscopical differences in the hairs of various animals are portrayed. The most striking differences are afforded by the cells and the linear markings on the cortical portions; difference in size is not of so much importance, since hairs of very different sizes may be found in the same animal.

FIG. 88.



Microscopic appearance of Hairs of various animals. 5. Hair of the spaniel, magnified 300 diameters (by measurement this had a diameter of $\frac{1}{1125}$th of an inch). 6. Hair or fur of the rabbit, $\frac{1}{1135}$th of an inch. 7. Hair of the hare; this structure is remarkable, being in the form of transverse cells; this kind of hair is found in the rodentia—viz., the squirrel, rat and mouse. 8. Hair of the horse, $\frac{1}{340}$th of an inch. 9 Hair of the goat, $\frac{1}{300}$th of an inch. 10. Hair of the fox, $\frac{1}{600}$th of an inch. 11. Hair of the cow, $\frac{1}{600}$th of an inch. 12. Hair of the fallow deer, $\frac{1}{250}$th of an inch in diameter.

The diameter of female hairs is usually some $\frac{1}{1250}$ or $\frac{1}{1300}$-inch less than that of male ones; the root of male hairs is some $\frac{1}{500}$ of an inch to $\frac{1}{300}$ wider than that of female ones.

When uncut, the hairs of men have also a broader point, and female hairs are far more affected by alkalies than are those of men.

The part of the body from which the hair has come may be determined partly by the general appearance, and partly by the diameters.

Hair cut by scissors usually retain a certain smoothness of section for many days; when hairs have been torn out violently they are generally crushed and frayed, the hair sheath being, as a rule, torn out, in company with the bulb. Hairs, however, that have been lost after fevers and other acute diseases, resemble those which have been torn out, as regards the hair sheaths and bulbs, and they may be accompanied by epidermic scales and blood in small quantities.

Arsenical and narcotic poisoning, ringworm and syphilis, may cause the hairs to come out of the head very easily.

The hair may slowly lose its colour from fright or grief. The hair of children, as a rule, greatly darkens as they advance in life. A man from thirty to forty-five years of age is occasionally greyer than one ten or fifteen years older. Certain soils alter the colour of the hair of bodies buried in them, and this effect has been attributed to *humic acid*. The hair may be changed in colour by chloride of gold, or bleached by chlorine, but chemical processes generally toughen the hair. The dye produced by the sulphides of lead, bismuth, and silver, may generally be dissolved out by the addition of nitric acid; and when tinged by pomade this substance may be dissolved out by ether or alcohol.

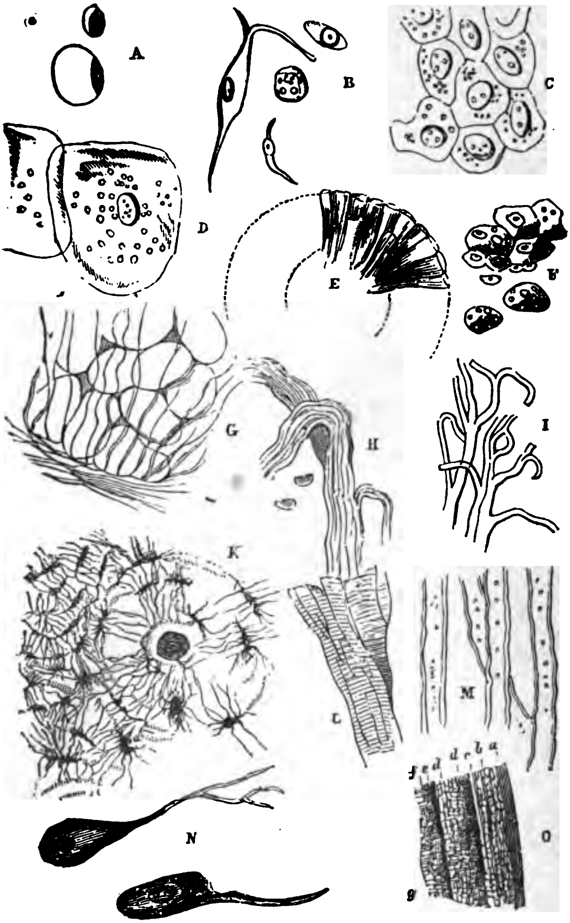
Hair resists putrefaction very powerfully, especially if the soil is dry. Indigo and ebony frequently adhere to the hair of those working in them, and copper oxide has been found in the hair of the workers in copper.

Brain-substance on Weapons.—Portions of brain-substance are occasionally found on weapons which have caused fracture of the skull and laceration of the brain. When the cerebral matter is fresh it cannot easily be mistaken, but when dry it becomes grey or brown, and horny. Upon being moistened, its colour becomes whiter and its consistence soapy. The only reliable method of its detection is by the microscope. If the matter is softened in distilled water, or in solution of sodium chloride, the presence of nerve cells or of nerve fibres may be discovered. These are small, being $\frac{1}{8000}$ inch, or even less, in diameter. They are generally ampullated, or they may be disorganised, only myelin drops remaining. Nerve cells are shown in Fig. 89 (N, O), in which many other structures are also exhibited, that may from time to time be of importance in medico-legal investigations.

Description of Fig. 89 (see next page).

A. Plan of the formation of a cell and a nucleus (Schleiden). B. Cells becoming developed into cellular tissue. C. Fragment of epithelium from a serous membrane. D. Epithelium scales from the inside of the mouth. E. Transverse section of an intestinal villus, in which is seen the form and arrangement of the columnar epithelium. F. Spheroidal epithelium. G. Fat cells and filaments of the cellular tissue. H, L. Muscular fibre. I. Elastic fibres of the yellow tissue. K. Transverse section of the compact tissue of bone, showing a section of an Haversian canal with the corpuscles or lacunæ (as they may be viewed), and the canaliculi extending from them across the laminæ. M. Arrangement of the capillary vessels amongst the muscular fibres. N. Nerve cells, as described by Hanover, from the grey matter of the brain. O. Plan showing the arrangement of the cells and fibres in the cortical substance of the brain; the letters *a* to *f* show the fibres in layers; *g*, points to where they come from, the central white matter intersecting the stratified white fibres of the cortical substance; the strata observed in the convolutions are arranged in white and grey layers alternately.

FIG. 89.



VARIOUS TISSUES AS SEEN UNDER A MICROSCOPE OF HIGH POWER.
(See preceding page.)

PART II.

TOXICOLOGY.

A POISON is any substance or matter (solid, liquid, or gaseous) which, when applied to the body outwardly, or in any way introduced into it, without acting mechanically, but by its own inherent qualities, can destroy life.

Classification of Poisons.—A scientific classification is still a great desideratum. The following classifications are taken: the first from Guy, the second from Taylor :—

1. Inorganic.
   - *Corrosive*—Sulphuric acid.
   - *Irritant*—Arsenic.
2. Organic.
   - *Irritant*—Savin, cantharides.
   - *Affecting lungs*—Carbonic acid.
   - „ *heart*—Digitalis.
   - „ *brain*—Opium.
   - „ *spinal cord*—Strychnina.

- Irritants
  - *Mineral*
    - Acid poisons—Sulphuric acid.
    - Alkaline poisons—Caustic soda.
    - Non-metallic—Phosphorus, iodine.
    - Metallic—Arsenic, antimony.
  - *Vegetable*—Savin, elaterium.
  - *Animal*—Cantharides.
- Neurotics
  - *Cerebral*—Opium, alcohol, hydrocyanic acid.
  - *Spinal*—Strychnina, nux vomica.
  - *Cerebro-spinal*—Conina, belladonna, aconite.
  - *Cerebro-cardiac*—Calabar bean, digitalis

The following classification is based mainly upon the arrangement in Guy's "Forensic Medicine."

INORGANIC POISONS.

CORROSIVES

The Mineral Acids.—Sulphuric acid, nitric acid, hydrochloric acid.

The Alkalies and their Carbonates.—Potash, soda, ammonia.

IRRITANTS.

Salts of the Alkalies and Alkaline Earths.—Sulphate and nitrate of potassium, salts of barium, strontium and calcium.

Metalloids.—Phosphorus, bromine, iodine, iodide of potassium.

Irritant Gases.—Sulphurous acid, hydrochloric acid, chlorine, nitrous acid, ammonia.

Metallic Irritants.—Arsenic, antimony, mercury, lead, copper, zinc, iron, tin, silver, bismuth, chrome.

ORGANIC POISONS.

NARCOTICS.

Opium, morphine, and their preparations.

DELIRIANTS.

Belladonna, hyoscyamus, stramonium, solanum nigrum, solanum dulcamara, solanum tuberosum. camphor, cocculus indicus, lolium temulentum, poisonous fungi.

DEPRESSANTS.

Tobacco, hemlock, lobelia inflata, Calabar bean.

CONVULSIVES.

Nux vomica, strychnina, brucina.

ASPHYXIANTS.

Carbonic acid, carbonic oxide, Carburetted Hydrogen, coal gas, nitrous oxide, sulphuretted hydrogen, sewer gases.

ASTHENICS.

Hydrocyanic acid, oxalic acid, aconite, digitalis, veratrum album, colchicum.

INEBRIANTS.

Alcohol, ether, chloroform, chloral, carbolic acid, nitro-benzole, benzole, anilin, oil of turpentine, creasote, Fousel oil, coal naphtha, Dippel's oil, nitro-glycerine.

VEGETABLE IRRITANTS.

Purgatives.—Aloes, colocynth, gamboge, jalap, castor-oil seeds, croton oil, elaterium, hellebores.

Abortives.—Savin, ergot of rye.

Irritants, with Nervous Symptoms.—Œnanthe crocata, cicuta virosa, phellandrium aquaticum, æthusa cynapium, yew, laburnum.

Simple Irritants.—Arum, mezereon, ranunculus, bryony (white and black).

ANIMAL IRRITANTS.

Cantharides, poisonous foods, trichiniasis, poisonous fish ptomaines, venomous reptiles and insects.

EVIDENCES OF POISONING.—These may be inferred from the following circumstances:—

Symptoms.—Usually these come on suddenly, the patient being in good health, and immediately or soon after having taken a meal, medicine, or drink.

Post-mortem Appearances.—Certain poisons present characteristic indications.

Experiments on Animals.—The dog and cat are most used, since they most resemble man in regard to the effects produced in them by poisons.

Chemical Analysis.—In a living person poison may be discovered in the urine, in the serum of a blister, or in the blood (obtained by bleeding, cupping, or leeching). In the dead body poison may be detected in the blood, the secretions, or the internal viscera.

Behaviour of Suspected Persons.—A suspected person may be shown to have bought poison, have studied the effects of certain poisons, have attended alone upon the dead person, prepared medicine for him, prepared his food, and have removed substances which might have been examined.

THE DIFFERENT CLASSES OF POISONS: THEIR SYMPTOMS AND POST-MORTEM APPEARANCES.

CORROSIVES.—The chief characteristic is the destructive action on all the parts with which they come in contact. Among inorganic corrosives are the mineral acids, the caustic alkalies and their carbonates, and corrosive sublimate; among the organic are carbolic acid and strong solutions of oxalic acid.

Symptoms.—These are, immediate burning pain in the throat, mouth, and gullet, with a strong acid taste, followed by vomiting of matters which contain shreds of mucus, blood, and membrane; difficulty of swallowing (dysphagia), thirst, difficulty of breathing (dyspnœa), an anxious and imploring countenance, with a frequent and small pulse, are also usually present.

Post-mortem Appearances.—Corrosion, mixed with corrugation, from strong contraction of the muscular fibres, and followed by inflammation and its consequences. The corrosions may be very small, or very extensive. The stomach, gullet, and mouth may be white, brown, or yellow, and the stomach filled with brown, yellow, or black fluid. The textures around the corroded parts are acutely inflamed.

IRRITANTS.—These substances inflame the parts with which they come in contact. They may be of two kinds—

A. Those by which life is destroyed simply through the local irritation they occasion (the principal vegetable irritants, the less active metallic poisons, irritant gases), and

B. Those which exert specific remote effects in addition to the local irritation (arsenic, antimony, lead, copper, phosphorus and iodine, cantharides).

Symptoms.—Burning and constriction in the gullet and throat, tenderness and pain in the stomach and bowels, nausea, thirst, purging, bloody stools, and vomiting, difficulty in passing urine (dysuria), coldness of surface, irregular feeble pulse; death resulting from collapse, shock, exhaustion, or convulsions, and in some cases from inanition or starvation, from injury to the œsophagus, by which food is prevented from entering the stomach.

Post-mortem Appearances.—Inflammation and its results. Thickening of the coats of the stomach, gullet, fauces, and duodenum which may be ulcerated or gangrenous. The surface studded with vessels filled with dark blood. The small intestines are often the seat of acute inflammation, the mucous membrane being ulcerated and softening.

POISONS ACTING ON THE BRAIN.—Of these there are three classes, as follows: 1, the opium group, producing sleep; 2, the belladonna group, producing illusions and delirium; and 3, the alcohol group, producing exhilaration succeeded by delirium or sleep.

Symptoms.—Those of the opium group are: giddiness, dimness of sight, headache, contracted pupils, noises in the ears, confusion of ideas and drowsiness, passing into insensibility. Of the belladonna group; spectral illusions, delirium, dilated pupils, thirst, and dryness of the mouth. Occasionally, though rarely, there may be paralysis and tetanoid spasms. Of the alcohol group: excitement of cerebral functions and of the circulation, loss of power of co-ordination and of muscular movement, with double vision, leading to profound sleep and deep coma. Delirium tremens is characteristic of the chronic form.

Post-mortem Appearances.—In the opium group: the veins and sinuses of the brain are full, and there is effusion of serum into the ventricles and beneath the membranes. In the belladonna group there are no special appearances. In the alcohol group: indications of inflammation, the brain and its membranes are congested, there is fluidity of the blood, and rigor mortis is of long duration.

POISONS ACTING ON THE SPINAL CORD.—Strychnina, &c. Tetanic spasm is the leading symptom.

POISONS AFFECTING THE HEART.—Death results by sudden shock, syncope, or collapse. Among these are, prussic acid, oxalic acid and the oxalates, aconite, digitalis, and tobacco.

POISONS ACTING ON THE LUNGS.—Carbonic acid gas is the type of these.

DISEASES SIMULATING POISONING BY CORROSIVES AND IRRITANTS.

Acute Gastritis.—This affection can, however. scarcely be said ever to occur idiopathically.

Asiatic and English Cholera and all Acute Inflammations of the Alimentary Canal, such as Dysentery.—The vomit in cholera seldom contains blood; this event is common in irritant poisoning. Pain and constriction in the throat is rare in cholera, and in this disease purging is an earlier symptom than it is in poisoning.

Ileus, Strangulated Hernia.—Here constipation is usually present, and the vomited matters are fæcal.

Rupture of Abdominal Viscera.—Sudden death has resulted from the rupture of the stomach directly after or during a meal, possibly due to an attempt at vomiting. Aneurism, rupture of the intestines, of the biliary ducts, uterus and other viscera, apoplexy of the ovary, bursting of the Fallopian tubes (in all of which collapse, pain, vomiting, and death in less than twenty-four hours have been observed) have been confounded with cases of poisoning. Post-mortem examination will, of course, reveal the true cause of death. Drinking a draught of cold water when heated has led to sudden death. The chief evidence in such a case will be the absence of poison.

DISEASES SIMULATING POISONING BY NARCOTICS, ETC.

In many diseases of the nervous centres, coma and insensibility are prominent symptoms. Similar symptoms occur in uræmic poisoning, epilepsy, apoplexy, hydrocephalus, blows on the head, and sometimes even in fever.

In **Epilepsy,** the history, the chronic nature, the length of the fits, and the peculiar character of the paroxysms will guide the diagnosis.

In **Apoplexy,** the general premonitory symptoms must be noted. It usually attacks the old, and it is frequently impossible to awaken the patient from the apoplectic sleep.

In **Poisoning** by narcotics there are no premonitory symptoms, persons of any age may be the victims, and with such poisons as opium it is possible to arouse the patient.

Idiopathic Tetanus is not common. The difference between this affection and poisoning by strychnina are the following:—

IDIOPATHIC TETANUS.	TETANUS OF STRYCHNINA.
Gradual supervention of symptoms, which are at first obscure, beginning with difficulty of swallowing. Trismus (locked-jaw), the *earliest* and most *prominent*, symptom, followed by stiffness of the trunk and extremities.	*Rapid* supervention of symptoms, reaching full development in a few minutes. Trismus only exists *imperfectly*, and may even be absent altogether.
Facies tetanica very characteristic. Opisthotonic attacks less frequent, severe, or extensive, not coming on for several hours or even days.	Facies tetanica very slight or absent. Opisthotonos very early active and violent.
Spasms *tonic* (persistent). Very rarely any intermission in the symptoms. Deglutition slow and difficult, sometimes impossible, the mouth being spasmodically closed. Death results after several hours or days, or recovery is very slow.	Spasms *clonic* (intermittent). Deglutition perfect but peculiar, fluids being gulped down with an effort, in a similar manner to that in which hydrophobic patients swallow. Death usually in less than three hours, or recovery very rapid.

Other poisons than strychnina may cause tetanus. but in this case the tetanus will be generally complicated with other symptoms. whereas in strychnina-poisoning tetanus is the one prominent symptom. The tetanoid convulsions of epilepsy and hysteria also must not be forgotten, although the general history of the case, the nature of the spasms, with the rapid alternations of relaxation and contraction, and the rarity of a fatal ending will usually point to a correct diagnosis.

When called to a case of supposed poisoning, the medical man must take possession of any medicine, food, vomited matter, fæces, or urine that may be in the room, and should seal them up for subsequent investigation, in perfectly clean vessels. He should observe the temperature of the body, its position, any marks of violence, the state of the rigor mortis and of the mouth and gullet; when making a post-mortem examination he should remove the alimentary canal and preserve it for further examination. A double ligature should be passed round the duodenum a few inches below the pylorus, and also round the œsophagus. The stomach may be removed entire, without the risk of spilling its contents, upon cutting the gullet and the intestine across beyond the ligatures. In a similar manner the intestines may be removed. The entire liver, or a portion of it, should be also preserved. The whole of these organs must be placed in a vessel, without any preserving fluid, then tied up, sealed, labelled, and initialled. As soon as possible al observations should be written down.

TREATMENT OF POISONING GENERALLY.

The first indication is to eliminate the poison by administering emetics, in order to cause vomiting, or by employing the stomach-pump. These methods, however, are not always admissible. Sulphate of zinc in 20-grain doses is one of the best emetics. In narcotic poisoning, after other emetics have proved useless, sulphate of copper in 6 to 10 grain doses has been effectual Vomiting may be sometimes excited by tickling the fauces with a feather. Mustard (a teaspoonful or two) in warm water, repeated frequently, and also common salt, are often useful emetics.

The next effort should be to arrest the action of the poison by giving some antidote. In cases of poisoning by acids or corrosive poisons, the appropriate remedies for each particular poison must be exhibited. Thus:—

For **Arsenical Preparations** the reputed antidote is the hydrated peroxide of iron.

For **Corrosive Sublimate** and other salts of mercury, and for the salts of **Copper**, the antidote is albumen.

For **Tartar Emetic**, any substances containing tannin.

For **Nitrate of Silver**, common salt.

For the **Mineral Acids**, magnesia or chalk, alkaline carbonates, and soap.

For **Oxalic Acid**, magnesia and chalk; whitening or plaster from the wall of an apartment. No *alkalies* should be given since these form compounds quite as poisonous as oxalic acid.

For **Ammonia, Potash**, or **Soda**, vinegar, or the diluted vegetable acids.

The third indication is to avert the tendency to death, and for this purpose the endeavour must be to mitigate the symptoms, to neutralise the subsequent action of the poison upon the system, and to promote elimination of the poison by stimulating the secreting functions. Stimulants, cold affusion, and galvanism are often useful in the case of depressants and in narcotic poisoning. In snake-bites the injection of ammonia into the veins has proved serviceable.

DETECTION OF POISONS

In examining any suspected matters, the general appearance, odour, and colour should be noticed. Seeds of plants may be found, or parts of insects, as cantharides. Colour may indicate salts of copper or bichromate of potassium, and an odour may be due to alcohol, opium, phosphorus, or hydrocyanic acid.

The contents of the stomach and intestines or the viscera should be then examined chemically.

The substance may be sometimes separated by simply filtering, and at other-times recourse must be had to Dialysis, in order to separate colloid (glue-like substances) from crystalloids.

Distillation is necessary in the case of volatile bodies such as prussic acid, chloroform, phosphorus, alcohol, and hydrate of chloral.

FRESENIUS' METHOD.—This is employed for the isolation of an inorganic substance from organic matter. The substance (in fine division) is boiled with about $\frac{1}{8}$th its bulk of pure hydrochloric acid, chloride of potassium being added from time to time until a straw-coloured fluid is formed. Disulphate of sodium in excess is added to this fluid, sulphuretted hydrogen being then added to saturation, so as to precipitate the metals as sulphides. From an acid solution, copper, lead, mercury (black or brown), tin, antimony, and arsenic (yellowish) are thrown down by sulphuretted hydrogen. If no precipitate results, solution of ammonia and sulphide of ammonium must be added, and a precipitate will then indicate iron (black), manganesium (pink), zinc (white), or chromium (green). The residue, after the addition of hydrochloric acid and chlorate of potassium, may contain silver, barium, and lead.

STAS' (OTTO-STAS') PROCESS FOR SEPARATING ALKALOIDS.—The pure alkaloids, excepting crystalline morphina, are soluble in ether, whereas the salts of the alkaloids are insoluble in ether, although the latter are soluble in alcohol and water. A solution is made of the stomach-contents, or of the solid organs cut up very finely by digesting these with water or acidulated alcohol, and then filtering. Ether is shaken with the filtrate to remove any oily matters; the ether is then separated, and the watery solution is neutralised by the addition of soda or potash, the alkaloid being finally removed by ether in a more or less impure state.

THE DETECTION AND IDENTIFICATION OF MINUTE QUANTITIES OF POISON.

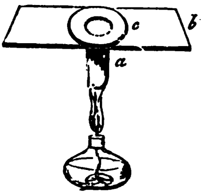
By successive divisions and subdivisions of a grain of strychnina strewn upon black glass, the $\frac{1}{10000}$ of a grain becomes visible to the naked eye as a bright speck. Under the microscope crystals of arsenious anhydride, weighing the $\frac{1}{230000000}$ of a grain, may be recognised. A single grain of gold may be divided mechanically into 490,000 visible pieces, and visible by the microscope into the amazing number of 4,900,000,000 fragments, so that it becomes less surprising when in reference to the metallic crusts obtained by Marsh's apparatus, the half-millionth or millionth of a grain is spoken of.

The $\frac{1}{30000}$ of sulphuretted hydrogen, $\frac{1}{40000}$ of bromine, and $\frac{1}{1300000}$ of oil of resin, will produce a distinct impression on the sense of smell.

The following are the methods employed for the detection of minute quantities of poisons:—

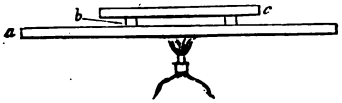
1. *Sublimation on to Flat Surfaces.*—The simplest form is with the spirit-lamp and platinum foil. Some poisons, as corrosive sublimate and arsenious anhydride, are sublimed without residue, whereas others, as the alkaloids, change their colour, melt, and deposit carbon. The most delicate method of subliming arsenic is the following:—The mixture of arsenious anhydride and charcoal is dropped into a clean and dry specimen tube (Fig. 90, *a*). This is supported in a circular hole by a metal or porcelain holder (*b*). The disc of glass (*c*) is first dried in the flame of a spirit-lamp, and then placed over the mouth of the tube. To the bottom of the tube the point of the flame is then steadily applied. The vapours of the metal when first disengaged unite with the oxygen of the air, and arsenious anhydride is reformed and deposited according to the temperature, either as an amorphous powder, or in glittering crystals. The crust consists of a mixture of arsenious anhydride, and the metal arsenium, and when examined by the lens or microscope by reflected light, the sparkling triangular facettes of the octahedral crystals of arsenious anhydride are seen projecting through a layer of metal.

FIG. 90.



If a drop of liquid supposed to contain arsenious anhydride be evaporated on a porcelain slab, and a stain is left, it may be tested as follows (Fig. 91). In heating the slab (*a*), the superimposed disc of glass (*c*) resting on the ring (*b*), will become misty, and upon microscopical examination this mist is seen to consist of crystals of arsenious anhydride.

FIG. 91.



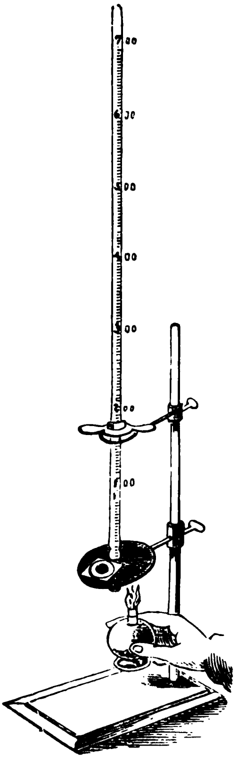
In this manner characteristic results may be obtained with even $\frac{1}{5000}$ of a grain of arsenious anhydride.

The following (Fig. 92) is a simple arrangement for noting the temperature at which changes of form and colour, and sublimation itself, take place. For the porcelain slab above described is substituted a disc of copper with a hollow nipple, so made as to receive a thermometer indicating degrees of heat up to 600° Fahr., or more. The substance under examination is placed on a fragment of microscopic glass turned into a shallow cell by a glass ring cut from a tube, a disc of microscopic glass resting on the ring. After placing the cell upon a copper disc, the flame of a spirit-lamp is applied steadily to the under surface of the copper at a point equidistant from the thermometer and the substance itself.

Of the most active poisons in quantities of the $\frac{1}{100}$th of a grain or less, supposed to be reduced to powder, the following are examples:—

A. Subliming without change of form or colour:—

FIG. 92.



Apparatus for testing poisons (inorganic and organic) and noting the temperature at which change of form and colour and sublimation occurs, showing the spirit-lamp applied to the substance placed on the disc of copper, with hollow nipple, in which is received the thermometer.

Arsenious Anhydride sublimes at 260°.

Calomel sublimes at 240°.

Cantharidine sublimes at 212°; melts at a higher temperature.

Corrosive Sublimate sublimes at 200°; also melts at a higher temperature.

The sublimate from calomel is amorphous (without form), but the first three substances yield crystalline sublimates, which consist respectively of octahedra, groups of plates and prisms, and groups of needles.

B. **Tartar Emetic** decrepitates at 380°, at 480° sublimes slowly and scantily, and at 550° chars.

C. **Strychnina**; until sublimation at 345°, no change of form or colour; at 430° melts, darkens, depositing carbon, still yielding sublimates.

Morphina; until its sublimation at 330°, no change of colour or form; melts at 340°, darkening and depositing carbon, still yielding sublimates.

2. *Liquid Reactions on Dry Spots.*—When a sublimate as pure corrosive sublimate or strychnina does not contain characteristic crystalline forms, the most minute drop of the appropriate test re-agent will reveal their true character.

If to a dry sublimate of strychnina, or to a dry deposit from a solution in which the alkaloid is contained placed under the microscope, a tiny drop of sulphuric acid is applied first and a speck of the colour-producing re-agent, such as bichromate of potassium or peroxide of manganese, be placed at the margin of the crust, at this part will appear the blue tint, passing through mulberry to light red.

The colour tests for strychnina act more characteristically in this mode than in any other.

3. *Liquid Reactions under the Microscope.*—This method consists in applying to so small an amount as a drop of some fluid (supposed to contain a poison), a still more minute amount of liquid re-agents. A drop bottle and spatula are employed, the drop bottle containing a pipette which dips into its liquid contents. The spatula is so formed that the smallest fraction of a drop of fluid may be taken up from the drip of the pipette. A drop of the suspected liquid is placed on a glass slide and examined, the re-agent is then applied and the effects observed. For this examination the binocular microscope is very important. When re-agents consisting of saline solutions are used care should be taken that the solution is of a defined strength, and the form of the crystals which it leaves upon evaporation must be ascertained previously—these crystals almost always form part of the dried spot.

4. *Minute Crystalline Forms.*—In detecting and identifying minute amounts of poison however obtained (by sublimation, deposit from solution, re-action of fluid with fluid, or liquid with dry spot) crystals play an extremely important part.

Toxicologically the crystals of chief importance are the following, viz.:—

The **Octahedron**; the typical form of arsenious anhydride.

The **Tetrahedron**; one of the two forms obtained from solutions of tartar emetic.

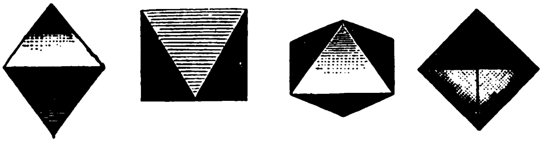
Prisms; *six-sided* as morphina, *four-sided* as strychnina and oxalic acid: *plates* as cantharidine; and *needles* as corrosive sublimate.

The octahedron and tetrahedron as a rule are isolated and detached, the rest arranging themselves in groups which present the utmost variety.

The *frontispiece* shows the regular octahedron in outline (A); as it appears when a glass model of it is seen with a triangular facette in advance (B); and as cleft by a plane parallel to two of its sides (C).

The regular octahedron consists of eight equilateral triangles, joined at their edges; and a section passing through four edges,

FIG. 93.



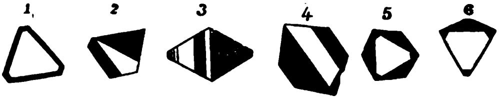
so as to divide the crystal into two equal parts, shows a perfect square. The section shown in C also divides the crystal into two equal parts, each of which has a hexagon for one face and an equilateral triangle for the other.

The entire crystal is presented under different aspects, according as it adheres by an angle, edge or face, and the light is reflected from it or traverses it.

In groups of crystals seen by reflected light, or in opaque models, two, three, or four sides only are exhibited as in the illustrations (Fig. 93).

When light is transmitted through the crystals, these forms are modified and disguised by shadows such as are seen in Fig. 94.

FIG. 94.



It is seldom that the eight sides of the octahedron are seen, as in the fifth of the series in which three dark triangular spots and three receding triangles represent six sides and two parallel equilateral triangles the seventh and eighth sides.

Occasionally, instead of being moulded on a square, the octahedron is built on an oblong, in which case it assumes the form of Fig. 95.

These forms of crystals can be recognised in most groups of crystals; still the octahedron is not always perfect. Its sides may be indented and its angles rounded, thus resembling a trefoil Fig. 96.

FIG. 95.

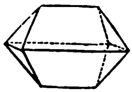
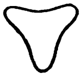
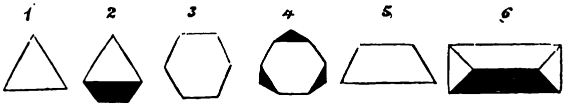


FIG. 96.



Like the entire crystal, the half crystal formed by the section indicated in C (*frontispiece*) may present itself in various different attitudes as shown in the following illustration (Fig. 97):

FIG. 97.



1, as a simple equilateral triangle; 2, as an equilateral triangle resting on half the adjoining triangle as a base; 3, as a simple hexagon; 4, as a hexagon with three small equilateral triangles in shadow; 5, as a truncated equilateral triangle; and 6, as a figure having the appearance of a triangular prism.

These half crystals, by the juxtaposition of their corresponding parts, form twin crystals or macles, as seen in Figs. 98 and 99.

FIG. 98.

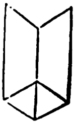


FIG. 99.

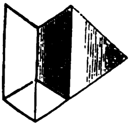
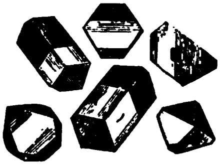


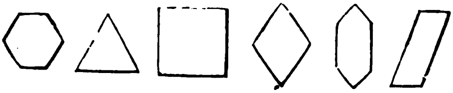
FIG. 100.



The rectangular prisms seen in Fig. 100 are of less frequent occurrence.

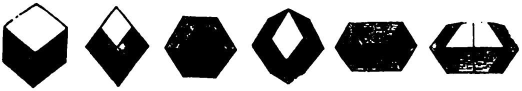
In some specimens, plates of various form, size, and thickness, as in Fig. 101, are also common.

FIG. 101.



The rhombic dodecahedron, shown in the various positions in the first four of the annexed figure (Fig. 102), and the twin crystals

FIG. 102.



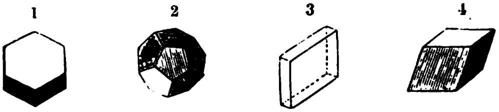
(macles) presented in the fifth and sixth, go far to complete the history of crystals of arsenious acid, taken as an example of a crystal of definite form, assuming appearances the most various, by reason of differences of position, rotation of half crystals, imperfect development, and modifications of form in harmony with the cubical system to which it belongs.

The tetrahedron shown in outline in D (*frontispiece*) together with the alternative form (F), (consisting of a cube with the edges removed) is interesting in a medico-legal sense from the fact that it is observed in some deposits from solutions of tartar emetic (potassio-tartrate of antimony). The tetrahedron consists of four equilateral triangles joined at their edges, and is constantly seen in the form depicted in the shaded crystal (E).

The remaining crystals important in medico-legal inquiries are principally the prismatic forms and plates holding a prominent place among the deposits and sublimates from solutions of the alkaloids. The chief are the following:—(G), of strychnina, the rectangular four-sided prism; (H), of morphina, the six-sided prism; and (I) of oxalic acid and sulphate of zinc, the right rectangular prism (see *frontispiece*).

Fig. 103 shows (1), the deep hexagonal plates of strychnina as

FIG. 103.



they appear when deposited from solutions of benzole; (2), the pentagonal dodecahedron observed in the same deposits; (3), the deep square plates of bichromate and ferrocyanate of potassium; (4), shows the rhomb, which is of less interest medico-legally.

The *frontispiece* shows (1), (2), (3), crystal forms occurring in deposits from a solution of *strychnina* in benzole; (4) a square plate (frequently modified by cross-marking and indentation as shown in the small enclosed figures) coinciding with (9); (5), wide, oblong plate variously truncated and disposed in groups belonging to the reactions of brucina with sulphocyanide of potassium and with perchloride of mercury; (6), leaf-like or winged form blended with oblong plates (5), shows the rapid reaction of *brucina* with ferricyanide of potassium, in which the iridescent (rainbow) colours of the thin curved plates in the manner of their projection in the liquid at every angle resemble some of the most delicate and beautiful of insect forms; (7), the flattened prism belonging to oxalic acid; (7), square prisms, and (8), hexagonal prism, belonging to strychnina and morphina respectively; (9) variously formed groups of plates and needles. These (4 and 9) are quite characteristic of the *instantaneous* reaction of *strychnina* and bichromate of potassium, and of the slower reaction of bichloride of platinum with this alkaloid; (9), the long rectangular plates, variously crossed and grouped, are equally characteristic of the *instantaneous* reaction of sulphocyanide of potassium with *strychnina* and also of tannic acid with morphina—the former in groups of great length and beauty, the latter usually detached and far smaller; (10), pointed prisms seen in perfection in the reaction of strychnina and the spirituous solution of iodine with sulphuric acid; (11), double group of needles, radiating from a point, occurring with crystals of straight and curved outline (5 and 6) in the reaction of brucina with ferricyanide of potassium (red prussiate of potassium), a very characteristic reaction. These forms, radiating from a point, are common in many marginal crystals, as, for example, *strychnina* with iodo-iodide of potassium and *morphina* with hydrochloric acid; (12), tufts common in *deep* drops, when in *shallower* ones groups of needles and fine prisms are abundant; (13), faintly marked and (14) thicker and coarser discs, and (15) with curved edges are blended with other crystalline forms, the last (15) being common in the reaction of *strychnina*, with perchloride of iron; (16) star-fish crystal, perfect and large, observed in the reaction of *brucina* with nitroprusside of sodium; (17), arborescent or dendritic form, occurring in the reaction of *strychnina* with terchloride of gold, and in a remarkable manner with carbazotic acid; (18), the curved claw-like figure, being the elementary form by which this last-named reaction is specially marked. In deposits from crystalline solutions these denditric forms are also common.

CORROSIVES.

THE MINERAL ACIDS.

1. Sulphuric. 2. Nitric. 3. Hydrochloric.

Symptoms.—The symptoms of poisoning by these acids depend upon the degree of their concentration, rather than upon their quantity; but the following are common to them all; there is an immediate burning sensation in the mouth, followed by violent pain, extending to the stomach, and accompanied by vomiting of dark-coloured *coffee-ground-like* matters, containing blood and portions of the lining membrane of the stomach. All the tract through which these poisons pass is shrivelled and corroded.

Sulphuric acid produces upon the skin a *dark brown or black stain* (*charring*) whilst black cloth is stained of a *dirty brown colour*, which afterwards becomes *red*.

Nitric acid turns the skin and woollen clothing of a *bright yellow colour.*

Hydrochloric acid stains the skin *white*.

Treatment.—Magnesia, chalk, plaster from an apartment, soap-suds, oil, milk, or mucilaginous drinks, linseed tea, gruel, eggs, and barley water are the appropriate remedies.

The stomach-pump should never be employed.

Post-mortem Appearances.—Corrosions and stains upon all the parts with which the acid has come in contact. The stomach is filled with *black*, *yellow*, or *brown* fluid, or distended with gas. The vessels of this organ are injected, and its mucous membrane inflamed or charred. Perforation of the stomach is more common in poisoning by sulphuric acid than by the other mineral acids. When this event takes place the aperture is irregular, its edges are blackened, and surrounded by intense inflammation and an indigo-blue tint is often observed in the mucous membrane.

SULPHURIC ACID. OIL OF VITRIOL.

Quantity Required to Destroy Life (*smallest recorded*).—One drachm.

Period at which Death has taken place (*shortest*).—One hour and three quarters.

Mode of Extraction from the Stomach.—The contents of the stomach should be filtered, and to the clear liquid any *soluble* salt of barium—*e.g.*, the nitrate or chloride—should be added; a *dense white precipitate* of sulphate of barium is formed; this is insoluble in all acids and alkalies, and may be reduced by charcoal before the blowpipe, yielding sulphide of barium, and this with a mineral acid gives off sulphuretted hydrogen, which may be known by its communicating a black stain to filtering paper dipped in a solution of lead.

Tests.—For the concentrated sulphuric acid are:—(1) its great weight; (2) its energetic union with water, giving out great heat; (3 its charring all organic matters; (4) with metallic copper it gives off sulphur dioxide, known by its odour.

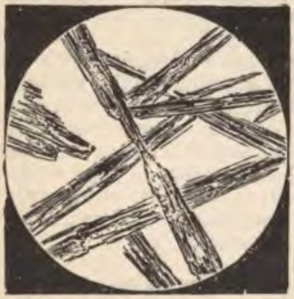
NITRIC ACID. AQUA FORTIS.

Quantity Required to Destroy Life (*smallest recorded*).—Two drachms.

Period at which Death has taken place (*shortest*).—One hour and three quarters.

Mode of Extraction from the Stomach.—If administered in such fluids as tea, vinegar, porter, &c., there will be a peculiar odour, in addition to the acid reaction produced by the strong acid. The *orange red* fumes of the oxides of nitrogen may *not be evolved* on boiling with copper filings unless the nitric acid is in considerable quantity; any viscidity in the liquid must be counteracted by dilution with water. Always filter; this operation is always very slow, and in its place dialysis may even be resorted to. After filtration the clear acid liquor should be warmed and a weak solution of carbonate of potassium added; after concentration by evaporation, paper, dipped into this solution and dried, burns with deflagration. A few drops of the filtered solution on a glass slide, slowly evaporated to dryness, give fluted prisms of nitrate of potassium (fig. 104); upon making a solution of these nitrate prisms in water and adding a *green crystal* of the protosulphate of iron (ferrous salt) with a drop or two of strong sulphuric acid, the crystal becomes of a *red-brown* colour, due to the formation of the persulphate of iron (ferric salt).

FIG. 104.



Crystals of Nitrate of Potassium.
(magnified 30 diameters).

Tests. — For the concentrated nitric acid are:—(1) stains the skin yellow, forming *picric* or *carbazotic* acid; (2) turns morphina and brucina *red*; (3) in the presence of hydrochloric acid dissolves gold leaf; (4) gives off *ruddy brown* fumes, with many metals, as copper, mercury, silver; (5) gives white fumes with the vapour of ammonia; (6) bleaches a solution of indigo.

HYDROCHLORIC ACID. MURIATIC ACID.

SPIRITS OF SALT.

Quantity Required to Destroy Life (*smallest recorded*).—Half an ounce.

Period at which Death has taken place (*shortest*).—Two hours.

Mode of Extraction from the Stomach.—As a considerable quantity of this acid must be present in the stomach to indicate a poisonous amount (hydrochloric acid and alkaline chlorides being natural constituents of the fluids of the alimentary canal), all that is necessary is to filter and add nitrate of silver, when a *white precipitate* of chloride of silver will be formed, which is known by the following characters: (*a*) it is soluble in liquor ammoniæ, and re-precipitated by nitric acid; (*b*) it blackens upon exposure to light; (*c*) when heated it melts to a mass, called horn silver.

Tests.—For the concentrated hydrochloric acid, these are:—(1) whitens the skin, forming chloride of albumen; (2) dissolves gold leaf in the presence of nitric acid; (3) gives off chlorine gas when added to dioxide of manganese; (4) gives white fumes with the vapour of ammonia.

THE ALKALIES.

Potash. Soda. Ammonia.

POTASH AND SODA.

Symptoms of Poisoning.—Potash and soda when taken in large doses produce similar symptoms. The most common form in which they are met with is as pearlash or carbonate of potassium, and soap-lees or carbonate of sodium. During the act of swallowing an acrid caustic taste is experienced, on account of the mucous membrane becoming excoriated by the alkaline solution, if concentrated sufficiently. There is burning heat in the throat, extending down the gullet to the stomach. Vomiting does not always occur, but, when it does, the vomited matters may be mixed with dark brown-coloured blood, and with flakes of mucous membrane. The local effects depend chiefly upon the degree of causticity of the fluid swallowed. There is purging, with colicky pain in the abdomen; the skin is cold and clammy; the pulse is feeble and quick. After a time the tongue, lips, and throat swell and become soft and red. Nitrate of potassium (saltpetre), bisulphate of potassium, bitartrate of potassium, potassium alum, and potassium sulphide, and even common salt (chloride of sodium) in large doses have acted as poisons.

Treatment.—Vinegar and water, or lemon, orange and lime juices should be given. Also oils, which form soaps with these alkalies. Opium should be given if there is much pain.

The stomach-pump must never be used.

Post-mortem Appearances.—When the case is recent the mucous membrane of the mouth, throat, and gullet has been found softened, detached, and exhibiting chocolate-coloured or even black patches. The larynx and windpipe have presented similar appearances. The mucous membrane of the stomach has also been destroyed in patches, and has been partially inflamed.

Quantity Required to Destroy Life.—Variable; the fatal result depending upon the degree of concentration rather than upon the quantity.

Period at which Death takes place.—Also variable. Three ounces of strong solution of carbonate of potassium killed a boy in three hours.

Mode of Extraction from the Stomach.—The soapy feel, the frothy appearance, and the alkaline re-action of the mixture, are characteristic of caustic potash, or soda and the carbonates of these alkalies.

1. It is usually sufficient to evaporate the suspected liquid to dryness, and then to heat thoroughly, in order to char the organic matter. The ash should then be digested with distilled water and filtered, upon which the alkali will be found in solution as the carbonate.

2. If it is necessary to separate the caustic alkali (potash or soda) from any carbonate that may be present, the liquid should first be evaporated to dryness, and the residue treated with absolute alcohol, in which the carbonate will not be dissolved, but in which the caustic alkali will be freely soluble.

Tests for Potash.—1. All the potassium compounds give a *violet* colour to the smokeless flame of spirit or gas. 2. The spectrum of this flame shows two bright lines—one in the red, the other in the violet. 3. Tartaric acid gives a *white* precipitate of cream of tartar (acid tartrate of potassium) on standing or stirring. The delicacy of this test is increased by the addition of a little alcohol. 4. Perchloride of platinum throws down a *yellow* granular precipitate of potassio-platino-chloride, falling slowly.

Tests for Soda.—1. All the sodium compounds are soluble, except the antimoniate, and gives an intense *yellow* colour to the smokeless flame of spirit or gas. 2. The spectrum of this flame shows a bright line in the *yellow* band, 3. Antimoniate of potassium throws down a *white* precipitate of antimoniate of sodium, providing that the liquid has been previously freed from all bases except the alkalies.

AMMONIA.

Symptoms of Poisoning.—The strong solution of ammonia produces symptoms similar to those of potash and soda, but since it is far more irritating, it induces a sensation of choking, followed by intense heat and burning pain in the throat, gullet, and stomach. One of the results of this poison is severe injury to the respiratory organs. A concentrated solution of carbonate of ammonium or sal volatile is an active poison in large doses. It produces stupor and insensibility, severe pain and vomiting, sometimes of blood There is sometimes obstinate constipation.

Treatment.—Similar to that of potash or soda. In poisoning by the vapour of ammonia, inhalation of acetic acid or diluted hydrochloric acid may be tried.

Post-mortem Appearances.—Corrosion of the mucous membrane of the mouth and throat has been observed. The viscera have shown strong indications of corrosion, the covering of the tongue being softened and peeled off. The membrane lining the air-passages may be softened and coated by layers of false membrane, the larger bronchial tubes being entirely blocked by casts of this membrane. The stomach has been found perforated, and its lining membrane congested and blackened, resembling somewhat the appearances presented in poisoning by oxalic acid or sulphuric acid.

Quantity Required to Destroy Life.—Variable.

Period at which Death takes place.—Also variable. Death has occurred in three days after swallowing the strong solution of ammonia, and has been protracted until three months after swallowing the carbonate.

Mode of Extraction from the Stomach.—Should the organic matter be in a state of decomposition, it will be almost useless to attempt to recover the ammonia, for not only is ammonia volatile, but it is itself also generated by decomposing animal matters.

If ammonia or its carbonate is present, the liquid has an alkaline reaction and an alkaline odour. About one-fourth of the organic liquid should be distilled over, the vapours being conducted through a bent tube into a well-cooled receiver containing a small quantity of water, acidulated by hydrochloric acid.

If no ammonia comes off in this way, the materials should be examined for other salts of ammonium as follows:—The residue in the retort should be treated with strong alcohol, and then filtered, the filtrate heated with caustic potash, and distilled as before. The acid solution may then be tested for ammonia.

Tests.—1. The salts of ammonium are white, are volatilised by heat, and if heated with caustic potash, soda, or lime, yield ammonia gas 2. All the ammonium compounds have a strong alkaline reaction. 3. Their solutions turn *red* vegetable colours *blue*. 4. Strong solution of ammonia gives *white* fumes, when placed near any mineral acid. 5. This solution, in excess, when added to a salt of copper, develops a beautiful deep sapphire colour. 6. It also gives a white precipitate with corrosive sublimate. 7. Perchloride of platinum gives a yellow precipitate of ammonio-platino-chloride. 8. *Nessler's Test.*—This is very delicate, and consists in the addition of caustic potash, with a solution of the red iodide of mercury and iodide of potassium to a solution of ammonia, or any of its salts, upon which a brown coloration or precipitate instantly appears, consisting of the dimercur-ammonium iodide.

Carbonate of Ammonium may be known from other salts in consequence of its odour, its alkaline reaction, and its volatility as a solid, and may be recognised from pure ammonia since it effervesces upon the addition of a mineral acid.

THE ALKALINE EARTHS.

BARIUM SALTS.

BARIUM CHLORIDE. BARIUM CARBONATE.

Symptoms of Poisoning.—(The chloride.)—A sensation of deadly sickness is experienced, accompanied by sharp burning pain in the stomach and bowels. There is violent vomiting and purging accompanied by tenesmus. The face is pallid and anxious, the eyes deeply sunk, the pulse and heart's action very feeble, and there is loss of muscular power, but intelligence and sensation are unaffected. Singing in the ears, and twitching of the face are experienced, terminating in convulsions and death. The symptoms produced by carbonate of barium are similar to the foregoing, but this salt is not nearly so powerful a poison as the chloride. The carbonate is employed as a rat poison. Death has occurred after taking 100 grains of the chloride, and recovery has taken place after half a teacupful of the carbonate has been swallowed.

Other salts of barium which have proved poisonous are the nitrate and the acetate.

Treatment.—The soluble sulphates, as those of magnesium and sodium, should be given. The stomach-pump may be employed if the case is seen early, and emetics should be used freely.

Mode of Extraction from the Stomach.—The contents of the stomach should be filtered:—

A. The residue on the filter should be boiled with carbonate of sodium, filtered, and the residue washed with distilled water acidulated with hydrochloric acid. The filtrate may be tested for baryta, the oxide of barium, as in the following case:—

B. To the filtered liquid diluted sulphuric acid should be added, and the mixture boiled and filtered. The filter paper should be ignited in order to burn away the organic matter. The residue should be boiled with water, acidulated with sulphuric acid, and again filtered and weighed.

Every 100 grains indicate 65·66 of barium oxide; the quantity of soluble barium salt is thus indicated.

Chemical Analysis.—The chloride of barium crystallises in plates, which are soluble in water.

1. It gives a *white insoluble* precipitate, with sulphuric acid, or with an alkaline sulphate 2. The powdered salt, burnt on plati-

num wire in a smokeless flame, imparts to this flame a *greenish-yellow* colour. 3. The chloride may be detected by silver nitrate, with which it yields a *white* silver chloride.

Carbonate of barium is an insoluble white powder. Upon the addition of diluted hydrochloric acid it is completely dissolved with effervescence of carbonic anhydride, and when evaporated presents crystalline plates of barium chloride.

STRONTIUM SALTS.

STRONTIUM NITRATE. STRONTIUM CHLORIDE.

These compounds are all, more or less, poisonous. The nitrate is largely used in the manufacture of fireworks

Tests.—1. These compounds, when ignited, render the flame of a *carmine-red* colour. 2. The soluble carbonates yield white insoluble precipitates, which are soluble in hydrochloric acid and in water containing carbonic acid. 3. Diluted sulphuric acid and soluble sulphates yield a white precipitate of sulphate of strontium insoluble in diluted acids.

Since the precipitate of sulphate of strontium is somewhat soluble in water, it does not form immediately upon the addition of the test solution.

CALCIUM SALTS.

Lime (oxide of calcium) is an irritant and caustic poison. In cases of poisoning, the soluble sulphates should be administered. It must be borne in mind that lime is a natural constituent of various tissues.

Tests.—1. The calcium compounds, when heated in the inner blowpipe flame, impart an *orange-red* colour to the outer flame. Hydrochloric acid should be first added to the insoluble salts before placing them in the flame. 2. The soluble carbonates yield white insoluble precipitates of carbonate of calcium. 3. Diluted sulphuric acid yields, in concentrated solutions only, a white precipitate of sulphate of calcium, slightly soluble in water. 4. Oxalate of ammonium produces a white precipitate of oxalate of calcium soluble in hydrochloric acid. The delicacy of this test is increased by the previous addition of a little free ammonia to the solution; with baryta and strontia a similar precipitate is occasioned.

THE IRRITANT GASES.

1. Nitrous acid gas. 2. Sulphurous acid gas. 3. Hydrochloric acid gas. 4. Chlorine. 5. Ammonia.

They all cause irritation and inflammation of the throat, eyes, and air passages, and may induce spasm of the glottis.

Nitrous Acid Gas constitutes the orange fumes which are given off when nitric acid is poured upon mercury or copper.

These fumes are produced on a large scale in the processes of water gilding and brass button making.

Sulphurous Acid Gas is one of the products of combustion of common coal. It is the chief cause of the irritating gusts from baker's ovens, and induces the diseases of the chest to which the London bakers are susceptible.

CHLORINE.

Symptoms of Poisoning.—This gas produces, even when it is largely diluted with air, considerable inflammatory action upon the eyes, the air passages and the lungs. Persons, however, who are accustomed to inhale chlorine are enabled to breathe a remarkable amount with impunity. It is stated that those who are constantly at work in an atmosphere of chlorine never get fat, or if they are fat when they commence the work they soon become thin. Exposure to chlorine vapour does not appear, however, to shorten life.

When chlorine is injected into the jugular veins life is destroyed rapidly, and after death the blood is found to be fluid and dark-coloured. Tidy states that one part in 200 will kill a sparrow in five minutes. The symptoms of poisoning by chlorine are immediate irritation of the epiglottis, windpipe, and bronchial tubes, tightness and oppression at the chest, dysphagia (difficulty of swallowing), and dyspnœa (difficulty of breathing), severe sneezing, swelling of the face and protrusion of the eyes.

Treatment.—The sufferer should be brought into fresh air, and made to breathe ammonia, ether-vapour or very diluted sulphuretted hydrogen. Inhalation of steam is also serviceable.

Tests.—The colour, odour, and bleaching properties.

HYPOCHLOROUS ACID.

Hypochlorite of sodium or chlorinated soda has caused death, the symptoms being a peculiar odour exhaled from the breath, accompanied by vomiting and intestinal irritation.

HYDROCHLORIC ACID GAS.

This gas is set free in the alkali works and in potteries. It is very prejudicial to vegetable and animal life.

METALLOID IRRITANTS.

Phosphorus, Bromine, Iodine.

PHOSPHORUS.

Symptoms of Acute Poisoning.—These vary considerably in their commencement. They may set in rapidly, but are frequently protracted. Usually in one or two hours there is a peculiar disagreeable taste, with intense warmth in the stomach and bowels, gradually increasing to violent burning pain. Eructations which have a garlic odour and are phosphorescent may be observed. Vomiting and purging are not unfrequent, the vomited matters being as a rule dark-coloured, and having the peculiar garlicky odour of phosphorus. The pulse is weak, thirst is intense, the pupils are dilated, the temperature low, the extremities cold, and the abdomen distended, but the intellect remains clear. The patient may rally and appear to be recovering, but about the third to the fifth day *jaundice*, retention of urine, and perhaps delirium, set in. Jaundice is recorded in 12 out of 16 cases. Relapse is generally sudden, and the patient will probably die within 48 hours of its occurrence either comatose or in convulsions. In a few cases paralysis has been observed. Recovery is very rare.

In **Chronic** poisoning by phosphorus there are, weakness and fatigue, griping pains in the abdomen, and diarrhœa, intermittent toothache, the teeth become carious, the gums swollen, retiring daily more and more from the teeth. and possibly offensive pus is seen issuing from them; the cervical glands may be more or less inflamed; eventually the jaw becomes exposed and is found rough and diseased. The complexion is sallow, there is gastric disturbance, accompanied by nervous irritability, eruption upon the skin. falling off of the hair, tubercular deposits, a black condition of the blood, and a great increase of phosphates in the urine.

The red or amorphous form of phosphorus is not poisonous. Poisoning by phosphorus is not nearly so frequent at the present day, since the red phosphorus is so much more employed than the yellow variety.

Treatment.—There is no chemical antidote for phosphorus. The great indication is to remove the poison from the stomach as quickly as possible. The stomach-pump may be used if the patient is seen soon after the poison is taken, otherwise an emetic of sulphate of zinc should be given.

Sulphate of copper is especially to be employed in 3-grain doses, well diluted, at short intervals. This substance forms with phosphorus a black phosphide, and has, therefore, been proposed as an antidote. Magnesia, or chalk mixed with gruel and alkaline drinks, should be administered freely, and if the poison has had sufficient time to reach the intestines a free purge should be administered. *No oil or fatty matters should be given*, since they dissolve the phosphorus, and thus assist its absorption. Animal charcoal, from its power of absorbing free phosphorus, has been recommended, and nitrate of silver has been stated to be an antidote for phosphorus poisoning.

The *crude French oil of turpentine* is also stated to be an antidote in phosphorus poisoning. With this substance phosphorus forms a spermaceti-like mass consisting of *turpentine-phosphorous-acid* which is not poisonous. If the case seems desperate transfusion of blood has been advocated.

Certain precautionary measures are necessary for those who are engaged in the phosphorus manufactories—viz., extreme *cleanliness*. the clothes being changed after work, and the face and hands washed in some slightly alkaline fluid. *Alkaline* drinks should be taken, and the mouth occasionally rinsed with a weak solution of carbonate of sodium.

Saucers filled with turpentine should be placed about the factory, in order that the vapours may be diffused thoroughly through the room.

Post-mortem Appearances.—These are generally those of an irritant poison, but they vary according to the *form* in which the poison has been taken. No special morbid appearances have been observed in some cases.

There is usually a peculiar jaundiced (icteric) hue of the skin. When the abdomen is opened, black patches may be seen, and perhaps luminosity of the stomach and other parts, which have been found inflamed and even gangrenous. The mucous membranes generally are softened and discoloured. The most important and uniform change in cases of chronic poisoning is the fatty alteration in the liver (which is sometimes associated with its atrophy) as well as in other soft organs, as the kidneys, gastric glands, the heart, muscles, and at times the aorta. This fat is undoubtedly produced by the decomposition of the albumen of the viscera.

Quantity Required to Destroy Life.—A child died after taking the $\frac{1}{50}$th of a grain. 1·5 grains killed a man, and $\frac{1}{8}$th of a grain a woman, in 12 hours. Recovery is, however. recorded in a child who swallowed a teaspoonful of phosphorus-paste, and in another child who had sucked 800 lucifer matches.

Period at which Death takes place.—(Variable.) From the third to the seventh day is the most common, but one case occurred in half an hour, one in 13 hours, one in 24 hours, and several others at periods varying from 2 to 12 days.

Mode of Extraction from the Stomach.—The garlic odour and the luminosity in the dark of the stomach-contents should be carefully looked for.

The odour of phosphorus in organic mixtures is very characteristic. When taken in a solid form the particles may be obtained as a sediment by merely washing the stomach-contents in water.

By plunging the tube containing them into hot water, or by pouring hot water upon them in a glass, these particles may be melted into one mass. Upon exposing a portion of the organic fluid in the dark, the luminosity of the phosphorus particles will be apparent, and if heat is applied to the surface upon which the material is spread, their combustion will take place. Bisulphide of carbon is a ready solvent of phosphorus, which may be separated from organic matters by means of this reagent. When the phosphorus has become converted in the body into phosphorous acid by oxidation it may be detected by the peculiar emerald-green colour which this acid imparts to the flame of nascent hydrogen.

The best method of extraction, however, is that of Mitscherlich, as follows:—The organic fluid should be distilled in the dark with a small quantity of diluted sulphuric acid, in order to neutralise any ammonia produced during putrefaction. The vapours should be conducted through a tube kept well cooled by running water, and the end of which passes into a receiver. The phosphorus vapour condenses in the tube, a flash of light appearing at each condensation of the vapour. The distillation should be carried on to dryness. This process will detect one part of phosphorus in 100,000 parts of substance.

BROMINE.

Symptoms of Poisoning.—In a case which proved fatal from taking one ounce of bromine upon an empty stomach, there was immediate difficulty of breathing, accompanied with intense pain in the stomach, great anxiety, with trembling of the hands and rapid pulse. The vapour, which is emitted at ordinary temperatures, is extremely irritating to the eyes and the lungs, exciting a sort of catarrh.

When bromine is administered internally it becomes rapidly converted into hydrobromic acid.

Post-mortem Appearances.—The stomach has been found externally injected, and internally coated by a thick black layer, the mucous membrane being intensely inflamed. The viscera in the vicinity of the stomach were of a deep yellow colour, the peritoneal coats of the stomach and duodenum injected. The odour of bromine has been detected in the stomach contents.

Mode of Extraction from the Stomach.—The colour, odour, and peculiar fumes are characteristic of bromine in the free state, but the mode of proceeding to extract it from organic fluids is the following:—The contents of the stomach should be filtered, and a little chlorine-water added to the filtrate. The whole should be shaken in a flask with ether, and the mixture allowed to stand for the ether to separate, which, supposing bromine to be present, will have acquired a yellow or reddish colour. Decantation must now be performed, and after adding a few drops of solution of potash, the fluid should be evaporated and the ether preserved. The bromine remaining in the flask should be dissolved in water, and again liberated by adding a little chlorine water. Upon adding a few drops of starch water, the *orange* bromide of starch will be instantly developed.

IODINE.

Symptoms of Poisoning.—There are immediate heat and pain in the throat and abdomen, with purging and vomiting. The vomit is probably of a brown or yellow colour, perhaps bloody. The stools often contain blood. Giddiness and fainting, with headache and convulsive movements, are not unfrequent.

Chronic or secondary effects are produced when iodine is applied externally, or given internally in small doses, producing the condition known as iodism. The manifestations are generally irritability of the alimentary canal and indigestion, constant vomiting, purging and pain in the stomach, enlargement of the liver, cramps, and palpitation. Salivation, increase of all the secretions, general wasting of the body, and special absorption of the breast in the female, and the testicles in the male, are stated to be ordinary symptoms.

After a mere medicinal dose, iodine may be found in the milk, sweat, blood, urine, and saliva. It will be found in the urine after forty minutes, and may not disappear for five days. The iodine is then present in the form of hydriodic acid.

Treatment.—Vomiting should be induced by emetics; farinaceous foods should be subsequently administered.

Post-mortem Appearances.—Those of an irritant poison the enlargement and congestion of the liver seem constant. The brain is usually congested, the lungs normal; little yellow ulcers have been found by Orfila in the stomach of dogs.

Quantity Required to Destroy Life.—(Variable). Bad effects have resulted from taking $\frac{1}{2}$ grain three times a day for a week, and death has resulted from 20 grains of iodine, whereas recovery is recorded after a drachm and a half has been taken.

Period at which Death takes place.—Usually within 30 hours after taking the poison.

Mode of Extraction from the Stomach.—The contents of the stomach must be filtered, and should the filtrate be colourless and clear, the iodine may be tested for at once by adding some starch solution, a blue colour appearing if iodine is present. If the filtrate is too dark-coloured to allow the immediate application of the starch, it should be shaken with its own bulk of ether, and after the ether has separated, the ethereal solution should be decanted and tested for iodine.

IODIDE OF POTASSIUM.

Very small doses of this salt, even 5 grains, have produced serious effects in persons peculiarly susceptible to its influence; and, on the other hand, some individuals have taken drachm-doses with impunity. Salivation has been observed on several occasions. The general symptoms are those of severe catarrh. Sometimes violent pains in the abdomen, with vomiting and purging, have been noticed. In some instances an eruption resembling small-pox has been produced by medicinal doses.

Mode of Extraction from the Stomach.—Sulphuretted hydrogen should be passed through the mixture to transform any free iodine into hydriodic acid. The mixture should be heated gently to expel any excess of the gas, and excess of potash added; it should then be filtered, and evaporated to dryness. The residue is then charred in a covered crucible, powdered, heated with *water and filtered*. It is then evaporated to a small bulk and chlorine added, to set the iodine free, and then, upon the addition of a little starch, the characteristic blue colour will appear.

METALLIC IRRITANTS.

ARSENIC.

The most important preparations of arsenic, from a medico-legal aspect, are the following, viz :—The white oxide or arsenious anhydride; orpiment, the yellow sulphide; Scheele's green, the green arsenite of copper; Fowler's solution, containing arsenite of potassium; by far the most important being arsenious anhydride, commonly called "white arsenic."

Symptoms of Acute Poisoning.—These are usually gradual in their development. They may be delayed for half an hour or an hour, or even longer, but cases are on record in which they have set in immediately when a large dose is taken.

Arsenic acts as an intense irritant. The countenance is expressive of great suffering. There is usually intense depression, followed by pain of at first a burning character in the pit of the stomach, and intensified upon the slightest pressure; diarrhœa with straining, burning pains at the anus, and painful cramps in the legs; violent vomiting is invariable, and it is aggravated by the reception of the least substance. The vomited matter consists of white gum-like substance, or of brown fluid mixed with bile and sometimes with blood. There are constriction and heat in the throat. The urine passed is generally diminished in quantity. Thirst is intense, the skin hot and dry, headache is acute, the pulse rapid and small, the breathing catching, the tongue furred and dry, the eyes smarting and suffused, the conjunctivæ red; great photophobia (dread of light) is present, with extreme restlessness, and nervous twitchings in the extremities, these being usually intense and long continued, but the mind is, as a rule, quite clear. The symptoms may terminate in convulsions of an epileptiform character, or the case may simulate English cholera; collapse may occur with intense coma, or a fatal result may take place almost immediately, as if by shock.

In any form whatever arsenic acts as a poison, whether gaseous, solid, or liquid; and in whatever way applied, either as a wash, an ointment, or a plaster.

Cases of poisoning by arsenic present the greatest variety in combination, character, and severity of the symptoms, and the most perplexing exceptions and anomalies.

Chronic Poisoning.—The symptoms are not so pronounced as in the acute poisoning. The eyes become watery and inflamed. There are at times an eruption on the skin (arsenical eczema) and local paralysis; salivation and even mania have been recorded. It is ascertained that arsenic has a specific action upon the digestive canal, and that this action is irrespective of the method of its administration; that the post-mortem changes in the chronic form are more noticeable at the pyloric extremity of the stomach, in the acute form at the cardiac end. The more gradual the poisoning, the more evident is the action on the intestines, and the less evident in the stomach.

The beneficial effects of arsenic as a drug are attributable to its peculiar action on the blood, thus diminishing tissue-change. The injurious effects appear to be due to destruction of the power of the blood to become oxidised, and this fluid being consequently unfitted for purposes of nutrition.

Treatment.—Should the case be seen very early or immediately after the poison has been taken, the stomach-pump may be employed, but never afterwards. Hot milk and water may be administered, and emetics of mustard or sulphate of zinc, simultaneously tickling the throat with a feather. Antimony should never be given. If copious vomiting has been induced, eggs and milk should be given; magnesia with sugar in milk is much to be recommended, since then an insoluble compound is formed with arsenious anhydride. The symptoms must be combated as they arise. Stimulants may be given for collapse, anodynes for the nervous indications, &c.

The reputed antidotes are the hydrated peroxides of magnesium and iron. The first is prepared by precipitating a strong solution of sulphate of magnesium with solution of potash; the second by precipitating the tincture or liquor of the perchloride of iron with excess of ammonia, collecting the precipitate on a filter-paper, and well-washing with water; but each must be obtained fresh, and exhibited when moist. Nitrate of potassium should be given in repeated doses, in order to act upon the kidneys, by which organs the poison is chiefly excreted.

Post-mortem Appearances.—In some cases no special appearances have been observed, but the usual indications are those of an irritant poison, the result depending upon the quantity taken and the length of time elapsing after the reception of the poison. The stomach is intensely inflamed, either in patches or throughout its whole extent, and in cases where death has resulted in two hours, the inflammatory redness may assume a *crimson velvet* appearance. The organ is generally studded with petechiæ, and particles of the poison may be found embedded in the rugæ if arsenic has been taken in a solid form. The coats of the stomach are usually thickened and corrugated; perforation and gangrene are rare. The inflammation may extend through the entire length of the intestines, but it is usually limited to the duodenum. The rectum is invariably inflamed. Although the kidneys, liver, and spleen are the great recipients of the poison, these organs generally present no special appearances. Arsenic possesses great preservative power upon the tissues; a body has been found well preserved seventeen months after poisoning by arsenic, and even longer periods have elapsed.

Quantity Required to Destroy Life.—It has been stated that the whole amount absorbed in fatal cases never exceeds two grains, no matter how much has been taken. Two grains have proved fatal, but recoveries have taken place after very large doses. The poisonous effects are said to be greatly increased when antimony has been given.

Period at which Death takes place.—(Variable.) It has proved fatal in 20 minutes, or death has been delayed for 10 or 16 days, or even longer. The usual time is 24 hours.

Mode of Extraction from the Stomach and Viscera.—(1) Solid white particles should be looked for with a magnifying glass, and if found these should be tested. Soot or indigo must also be looked for, since arsenic may have been mixed with these substances. The liver, spleen, and urine should be examined, for in these the largest quantity may be discovered, and even when no trace of the poison can be found elsewhere. (2) The tissues should be cut up very fine, then diluted with the stomach-contents, and distilled water in sufficient quantity added to render filtration easy; hydrochloric acid should now be added; then the mixture must be filtered, and the filtrate divided into two parts, A and B.

Through A pass sulphuretted hydrogen and test the precipitate. B should be examined by Reinsch's process.

The contents of the stomach may be examined both by Marsh's and Reinsch's tests.

The **Tests** for arsenious anhydride may be divided into three groups:—

1. Solid; 2. Liquid; and 3. Special.

The solid tests are two in number:—

(1) Arsenious acid, when heated upon charcoal, emits an odour of garlic. (2) When it is heated in a reduction tube with black flux (*i.e.*, dried carbonate of sodium and charcoal), metallic arsenic is formed, which condenses as a ring upon the upper part of the tube.

The liquid tests are three:—

(1) Sulphuretted hydrogen gives a *yellow* precipitate of sulphide of arsenic soluble in ammonia.

(2) Ammonio-nitrate of silver (made by adding just enough liquor ammoniæ to the nitrate of silver to precipitate the brown oxide of silver) gives a canary yellow precipitate of arsenite of silver or Hume's yellow soluble in excess of ammonia.

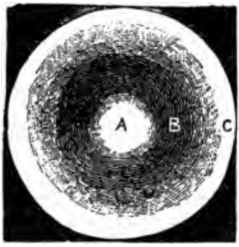
(3) Ammonio-sulphate of copper (made by adding to a solution of sulphate of copper just enough liquor ammoniæ to throw down a pale-blue precipitate) gives a *green* precipitate of arsenite of copper, or Scheele's green, soluble in excess of ammonia.

The special tests are two in number.

(1) **Marsh's Test.**—This consists in the decomposition of arsenious acid by means of nascent hydrogen. A suitable vessel is taken, and in it are placed some strips of zinc with water and sulphuric acid. Hydrogen gas is thus generated, and escapes through a

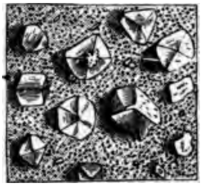
gas-jet with which the vessel is furnished. This gas burns with a very faintly luminous flame when a light is applied, the result of its combustion being only a few drops of water. The arsenious acid is now added to the contents of the vessel. The hydrogen flame is converted into arseniuretted hydrogen, and burns with a *pale-blue* flame. A white porcelain plate is now placed over this last flame, and a deposit is formed which may be divided into three rings. as shown in Fig. 105. This deposit is soluble in a solution of chlorinated lime, but insoluble in hydrochloric acid (thus distinguished from the antimonial deposit which is insoluble in the former but dissolved by the latter reagent). If to the deposit nitric acid is added (thus converting the arsenious anhydride into arsenic anhydride), ammonio-nitrate of silver will give with it the ***brick red*** arseniate of silver. Fig. 106 shows the microscopical appearance of an arsenical crust.

FIG. 105.



Deposit obtained from Marsh's Apparatus. A. Arsenium (metal). B. Arsenium and arsenious anhydride (mixed deposit). C. Arsenious anhydride.

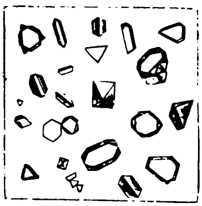
FIG. 106.



Arsenical Crust, examined under the microscope by reflected light. Showing distinct octahedral crystals or masses of crystals of arsenious acid, more or less thickly coated and obscured by light brown or grey metallic deposit.

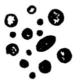
(2) **Reinsch's Test.**—This consists in boiling bright strips of copper in an arsenical solution previously acidulated by hydrochloric acid. Metallic arsenic becomes deposited upon the strips of copper, which are then withdrawn and placed in a reduction tube, with the same result as has been described above under the solid tests.

FIG. 107.



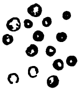
Crystals of Arsenious Acid as seen under the microscope by transmitted light.

FIG. 108.



Mercury Globules, quite smooth, sublimed from copper (magnified 150 diameters).

FIG. 109.



Arsenic deposited on Copper by Reinsch's process and sublimed as globules, not presenting so smooth a surface generally as in the case of mercury, and somewhat granular.

This last test is also employed in the detection of antimony and mercury. The differences are the following:—

The deposit in the case of antimony is *violet*, and in the reduction tube its sublimate is amorphous, and insoluble in water.

The deposit in the case of of mercury is *bright and silvery*, its sublimate consisting of bright metallic globules (Fig. 108).

The deposit in the case of arsenic is *steel-grey*, and its sublimate consists of octahedral crystals, sparingly soluble in water. The presence of these octahedral crystals is confirmatory of the existence of arsenic. Fig. 109 shows some of the many forms assumed by crystals of arsenious anhydride as seen under the microscope by transmitted light.

The purity of the copper foil used in Reinsch's test, *i.e.*, to prove its freedom from arsenic, may be shown as follows:—

A. When clean copper strips are boiled for some time with *pure* hydrochloric acid without apparent tarnish, the copper may be regarded as pure.

B. Ten grains of the copper should be placed in a small glass retort and heated with about twenty grains of the precipitated peroxide of iron and hydrochloric acid in excess. It should then be distilled to dryness in a little water. Any arsenic in the copper will be found in the distillate as chloride of arsenic.

ANTIMONY. STIBIUM.

The most important preparations of antimony are tartar emetic, or the potassio-tartrate of antimony, and the chloride of antimony.

Symptoms.—In **Acute** poisoning there are a strong metallic taste during the act of swallowing, constriction, heat and soreness of the throat and mouth, succeeded by nausea, vomiting, tenderness and pain in the stomach, and followed by profuse diarrhœa; a small quick pulse, cold skin, clammy sweats, and intense prostration. Death may occur in this condition of collapse, but sometimes it is preceded by delirium, convulsions, and tetanoid spasms. Insensibility is sometimes one of the earliest effects of large doses of antimony; a characteristic pustular rash has in some cases been observed in the throat and upon the skin. In rare instances no vomiting or purging has been present until after the administration of emetics.

Chronic Poisoning.—There are nausea, vomiting, and purging, extreme weakness and fatal exhaustion. Infants and young children appear to be greatly tolerant of tartar emetic, especially when suffering from affections of the lungs or larynx. Applied externally as an ointment or lotion, tartar emetic occasions inflammation of the skin, and a crop of pustules, and if continued may induce sloughing. Its external use has been followed by nausea and vomiting.

Treatment.—When no vomiting is present, it should be induced immediately by draughts of warm water, or hot milk, and by

a

tickling the fauces. In the event of these methods failing, the stomach-pump should be employed.

The proper antidotes are, cinchona bark, or any fluids containing tannin, such as strong tea, infusion of gall-nuts, or decoction of oak-bark. As soon as the poison has been removed from the stomach, strong coffee may be given, and to stay the vomiting opium may prove of service.

Post-mortem Appearances.—Inflammation of the mucous membrane of the stomach, sometimes extending to the small intestines, and rarely to the gullet and throat. The stomach and bowels are usually coated by thick viscid slimy mucus. The brain and its membranes, and the lungs are sometimes inflamed. If death has occurred from repeated small doses, the state of the cæcum and large intestines should be carefully inspected. The blood is usually black and fluid.

Quantity Required to Destroy Life.—Variable. Two grains have proved fatal to an adult, and three-quarters of a grain to a child. Very severe effects have followed a dose of six grains. Large doses, such as one ounce, however, have been taken with impunity, by reason of the rapid rejection of the drug from the stomach.

Period at which Death takes place.—Variable. Tartar emetic in a single large dose may destroy life in a few hours, but a patient has survived nearly five days after taking forty grains, and twenty grains has proved fatal to a woman after a year of suffering.

Mode of Extraction from the Stomach.—The salts of antimony are decomposed by all vegetable substances containing tannin, and in strong solutions they coagulate milk. The stomach-contents should be diluted with water, filtered and acidulated with tartaric acid, and then sulphuretted hydrogen gas should be transmitted through the liquid, in which case the orange sulphide will be precipitated. The colour of the precipitate may be rendered more or less brown from admixture with organic matters. Should this method fail, Reinsch's or Marsh's test may be employed (see Arsenic, pp. 111, 112).

If the quantity found in the stomach-contents exceeds the ordinary medicinal dose, there is a strong presumption of poisoning, but if the amount is small, it is impossible to say that it has been administered criminally, until proof is forthcoming that it has not been given as a medicine. Antimony is absorbed and may be discovered in the secretions, the blood, and solid viscera. The same method of detection may be employed as in the case of arsenic.

The urine should always be examined for antimony. The elimination of the poison by the kidneys is very rapid. When the quantity present is very small, it has been recommended to suspend in *a weak acid solution*, a coil of pure zinc foil, wound round a piece of platinum foil, when metallic antimony will be deposited upon the platinum. This deposit may be treated as follows :—

1. Wash and digest in strong nitric acid, until the deposit is dissolved, and then evaporate to dryness. Dissolve the residue in hydrochloric acid and add to the solution sulphuretted hydrogen.

2. Or dissolve the residue in sulphide of ammonium, evaporate to dryness, and thus obtain the orange red sulphide.

Tests for the Compounds of Antimony :—

1. The *orange* precipitate with sulphuretted hydrogen, soluble in sulphide of ammonium. This is the only orange sulphide.

2. The chloride of antimony when placed in water yields a *white* precipitate (powder of Algaroth).

3. Antimoniuretted hydrogen burns and deposits two rings on a white plate held in the flame. These rings are soluble in sulphide of ammonium, but not in a solution of chlorinated lime (thus distinguishing the gas from the arseniuretted hydrogen).

4. Infusion of cinchona, and any solution of tannic acid produces a copious *dirty brown* precipitate with salts of antimony.

MERCURY AND ITS PREPARATIONS.

The most important salt of mercury, from a medico-legal aspect, is corrosive sublimate or perchloride of mercury, but other preparations have been used as poisons, viz., calomel, or the subchloride of mercury; white precipitate, or hydrargyrum ammoniatum; red precipitate, or the peroxide; turpeth mineral, the oxysulphate; mercuric sulphide, mercuric and mercurous nitrate, - mercuric cyanide, mercuric sulphocyanide, or Pharaoh's serpent, and mercuric methide.

Symptoms of Poisoning.—Those of **Acute** mercurial poisoning appear very soon, frequently immediately after, or in the act of swallowing. There is a coppery taste with sharp burning pain, extending from the throat to the stomach. The mouth and tongue look white and shrunken, as if they had been soaked in a solution of nitrate of silver. The countenance is very anxious and the face flushed. The breathing is difficult, the pulse thready, the abdomen swollen and painful, the pain being much increased on pressure; pain is, however, in some cases absent. Thirst is intense, and there is vomiting of white stringy or bloody mucus. The skin is cold and clammy, the stools bloody, and the urine is more or less completely suppressed. About the third day salivation sets in, but this is not an invariable symptom in acute cases.

Death soon proves rapid from collapse, but it is sometimes accompanied by convulsions, and at other times intense coma sets in, from which the patient never recovers.

The points of distinction between poisoning by this perchloride and by arsenic are as follow:—They begin sooner after the swallowing of the poison; the taste of corrosive sublimate is inintensely metallic; there is intense burning in the gullet and throat; blood in the stools and in the vomit is far more frequent. The activity as a poison over arsenic is due to the greater solubility of the mercury salt and its more intense chemical reaction upon animal structures.

Treatment.—White of egg or wheat flour, mixed with milk, should be given at once. It is stated that the white of one egg is capable of neutralising 4 grains of corrosive sublimate. Vomiting should be encouraged, and therefore emetics should be given For troublesome salivation gargles of chlorate of potassium and alum should be used. The subsequent treatment must depend upon the symptoms, but it is advisable to give white of egg in milk for some weeks two or three times daily.

In **Chronic** poisoning the symptoms are mercurial tremors and shaking palsy, and they occur in those exposed to mercurial fumes. or who are engaged in handling compounds of mercury. They usually commence with nausea, vomiting, and debility, a constant coppery taste in the mouth, and colicky pains frequently recurring. The breath is fœtid,. swallowing and breathing are difficult, and frequent hacking cough, and sometimes hæmoptysis occur. Eventually ptyalism (salivation) becomes a prominent symptom, the gums and tongue becoming swollen, painful, red. and even ulcerated. In the saliva the metal will be discovered. Trembling and convulsive motions of the limbs, or mercurial tremors. are well marked ; the upper extremities are first attacked, then the lower, and thus walking is made difficult. By active treatment the patient may recover, but, nevertheless, death may occur from extreme exhaustion, with gangrene of the mouth, and other indications.

Post-mortem Appearances.– The salivary glands are found enlarged, saliva dribbling from the mouth. The abdomen is usually tympanitic. The mucous membrane of the throat and mouth is greyish-white. but at times it is extremely inflamed, and even corroded. Where salivation has occurred the parts may be in a condition of slough. The stomach is frequently coated by a slate-coloured layer of finely-divided mercury. or should putrefaction have set in it is covered by a black precipitate of sulphide of mercury. At times it is the seat of intense inflammation. There is generally much congestion of the intestines and of the urinary organs, the bladder being frequently contracted and empty. It is stated that corrosive sublimate takes four hours to reach the saliva and two hours to reach the urine, in which fluids it may be detected.

Quantity Required to Destroy Life.—The smallest quantity recorded is 3 grains. Recovery has occurred after 80 grains have been taken. Adults are more susceptible to its action than children.

Period at which Death takes place.—Death has taken place within half-an-hour, but has been delayed for 16 days. The average period is 3 to 6 days.

Mode of Extraction from the Stomach.—The contents of the stomach, with the tissues cut up, should be mixed and crushed in a mortar, sufficient alcohol being added to make filtration easy.

The mixture should be acidulated with hydrochloric acid and gently warmed. It should then be filtered, and the filtrate tested by sulphuretted hydrogen and by Reinsch's test.

The preceding process indicates the presence of mercury, but not of the perchloride To find this salt the contents of the stomach should be concentrated by evaporation, and then shaken with a large bulk of ether, which is a great solvent of corrosive sublimate. The ether must then be carefully decanted, and distilled at a gentle heat, the residue being tested for the salt.

The saliva may be tested for mercury by acidulating about 2 drachms of it with hydrochloric acid, and placing in the mixture a small piece of clean bright copper, observing if it becomes covered with a silvery coating. Upon heating the copper in a reduction tube, metallic mercury may be obtained. The urine may be examined for mercury by taking 14 ounces of the fluid and evaporating to one ounce, then adding hydrochloric acid, filtering, and boiling the filtrate with a piece of bright copper, and placing it in the reduction tube.

Tests for the Mercury Compounds.—(1) All the mercurial salts sublime, and can be decomposed by heat. (2) By charcoal and sodium carbonate, metallic mercury is obtained (The Reduction Test). (3) Bright copper strips when placed in an acidulated solution become coated with metallic mercury. (4) Stannous chloride in excess precipitates the metal (black). (5) Bright gold or copper moistened with a solution of mercury, and touched with a pointed steel, becomes coated with a white silvery stain.

Tests for the Mercurous Salts.—(1) Liquor calcis and all the alkalies throw down a *black* precipitate ("black wash"). (2) Iodide of potassium gives an *olive-green* precipitate. (3) Chromate of potassium gives a *bright-red* precipitate. (4) Sulphuretted hydrogen gives a *black* precipitate.

Tests for the Mercuric Salts.—(1) Liquor calcis and all the alkalies, except ammonia, give a *yellow* precipitate ("yellow wash"). (2) Liquor ammoniæ, with corrosive sublimate, gives a *white* precipitate. (3) Iodide of potassium gives the *scarlet* iodide of mercury, soluble in excess of either re-agent. (4) Sulphuretted hydrogen in excess gives a *black* precipitate, becoming *red* when sublimed.

LEAD. PLUMBUM.

From a medico-legal view, the most important salts of lead are the acetate and carbonate; but in medicine, the two oxides, the sub-acetate and the sulphate, chloride and nitrate are used.

Symptoms.—In **Acute** poisoning the symptoms are those of a weak and rarely fatal irritant poison. Soon after swallowing there are dryness of the throat, metallic taste, and thirst. The prominent indication is severe and frequently intermittent colicky pain, chiefly referred to the umbilicus, and to which pressure gives relief. There is usually much rigidity of the abdominal muscles. The pulse is very slow and weak; the face anxious, and dingy looking, and there is extreme prostration. Constipation is invariably present, the muscular coat of the intestines being paralysed (thus differing from most irritant poisons). The urine is very red, and generally scanty. With the progress of the case, cold sweats, severe cramps, paralysis of the lower limbs, and often tetanoid spasms, and convulsions occur. Vomiting is not constant, and the mind is generally clear to the end.

Treatment.—At first free vomiting should be encouraged with warm water or sulphate of zinc, or the stomach-pump may be used if these measures fail. The proper antidotes are the soluble earthy and alkaline sulphates; sulphate of magnesium is certainly the best, and it may be exhibited freely with eggs. For the relief of pain, opium may be given; and if much constipation is present, purgatives should be employed. Injections are frequently useful. Since carbonate of lead is itself a poison, carbonates are clearly contra-indicated.

Quantity Required to Destroy Life.—Variable. One drachm of the acetate has been taken for ten days daily before symptoms of poisoning appeared; one ounce has been taken without effect, and on the other hand, alarming results have followed from two drachms, and mere medicinal doses have given rise to symptoms of acute poisoning.

Period at which Death takes place.—Variable. Death has resulted at the end of three days, and cases are recorded of two children who died in thirty-six hours after swallowing Goulard's extract (a solution of the subacetate of lead).

Chronic lead poisoning (saturnine poisoning) may take place in three ways—

1. Where the lead has been swallowed, as in drinking water, &c.
2. Where it has been applied externally, as in using hair-dyes and cosmetics.
3. Where it has been inhaled, as with artists and painters generally.

The progress of the symptoms is often slow. At first there are indigestion, intense depression, and obstinate constipation; then loss of appetite, unquenchable thirst, intensely fœtid breath, and constant metallic taste in the mouth. The countenance is dull and anxious. Fever is unusual and the pulse is normal. Colic is a frequent symptom, and the navel is retracted. If the bowels act, the motions are blackened from the formation of sulphide of lead, and their passage is attended by pain. The urine is generally scanty, and micturition is painful. Vaginismus in the female is frequently observed.

Sometimes a case will end favourably, but at others a variety of apoplexy ensues, rapidly proving fatal with convulsions and coma. In a large majority of cases lead paralysis appears. This symptom may arise after a single attack of chronic poisoning, but it usually ensues after a succession of attacks, and it has occurred in the absence of any attack whatever.

It is remarkable that the upper limbs, especially the extensor muscles, are the most liable to be attacked, and the extensor muscles of the forearm (dropped wrist) and arm are those in which the loss of power and wasting are first observed.

The great sign, however, is the *blue line* in the gums fringing the margin of the teeth. It occurs very early, and is very rarely wanting.

This line is due to the action of sulphuretted hydrogen, derived from the fluids of the mouth, upon the lead circulating through the capillaries.

Iodide of potassium is considered a useful remedy in chronic lead poisoning, and it may be given in doses of five to ten grains daily. Sulphate of magnesium, with diluted sulphuric acid, is exceedingly valuable. Opium and castor oil, and even croton oil, have proved serviceable. When the dropped wrist is well marked, business must be given up, and friction and electricity may be advantageously employed, and strychnina internally may confer benefit. With those exposed to lead by their occupation, preventive measures are of extreme importance, viz.: great cleanliness, the clothes being made of compact linen, and not of woollen material. The diet should be very digestible, and, before eating, the teeth should be well brushed. Sugared water, with sulphuric acid, should be employed as a beverage. Free currents of air should be allowed to pass through the workshops to carry off any floating metallic particles.

The action of water on lead is worthy of note. The corrosive action of water on lead is decreased by the presence of sulphates, carbonates and phosphates; whereas its action is increased by chlorides, nitrites, and nitrates.

Post-mortem Appearances.—In acute poisoning frequently no marked effects have been seen. Sometimes inflammation of the intestinal canal has appeared, and the intestines have been generally found contracted. The stomach, at times, has looked white, as if through the corrosive action of the metal.

In chronic cases nothing specially definite has been seen, with the exception of the large intestines being contracted, and the specially affected muscles being flabby and whitish, somewhat resembling white fibrous tissue.

Post-mortem examination, however, has shown that the bones contain more lead than the kidneys and liver: the muscles, blood and intestines less than other parts, even than the spinal cord and brain.

Mode of Extraction from the Stomach.—1. The contents of the stomach should be first treated with water and nitric acid, in order to form the soluble nitrate of lead. Then sulphuretted hydrogen gas should be passed through the solution. If the lead has been rendered insoluble by albumen or casein normally present, or by the antidotes administered, then the materials should be incinerated, and the ash dissolved by heat in diluted nitric acid and filtered, and through the filtrate sulphuretted hydrogen passed.

2. Carbonate of sodium may be boiled with the contents, and the mixture filtered; acetic acid should then be added to the residue on the filter, and sulphuretted hydrogen passed through the solution, the sulphide of lead being collected and weighed.

The black precipitate may be proved to contain lead, as follows:—

1. By placing the dried precipitate on a piece of charcoal, and reducing it to the metal by the blow-pipe.

2. By exposing the precipitate to red heat, in a tube open at both ends, to expel the sulphur, adding to the residue strong nitric acid, and diluting the resulting solution with water. This will now yield the lead reactions.

In order to determine the presence of lead in water, take two clear white pint bottles, through one pass washed sulphuretted hydrogen for some time, and compare the colour of this with that of the other in a good light, carefully observing if any darkening has taken place.

Tests for the Lead Salts.—(1) The alkalies give white precipitates. (2) Sulphuric acid gives an insoluble white precipitate. (3) Iodide of potassium gives a yellow precipitate. (4) Bichromate of potassium gives a yellow precipitate. (5) Sulphuretted hydrogen gives a black precipitate.

COPPER. CUPRUM.

The most important salts of copper which have proved poisonous are the following:—The sulphate (blue stone, blue vitriol, or blue copperas); the nitrate; the carbonate (natural verdigris); the acetate (artificial verdigris); the chloride; the oxychloride (Brunswick green); arsenite of copper (Scheele's green); and the hydrated peroxide (contained in mineral green).

Symptoms of Acute Poisoning.—The copper salts in full poisonous doses act as irritants. There is an immediate astringent coppery taste in the mouth, accompanied by burning heat in the throat; then vomiting of green or blue-coloured matters, and perhaps pieces of the salt may be found in the vomit. It is an easy matter to distinguish the vomit from bilious vomit, the former giving with liquor ammoniæ a deep blue colour, the latter being unaffected by this re-agent. Within half an hour severe headache, dizziness, and thirst set in. The pulse is irregular and small, and there is excessive sweating. Severe purging, intense colic with tenesmus, troublesome eructations, suppression of the urine, spasms and cramps are common, and in severe cases, tetanoid convulsions and complete unconciousness may result. The special symptom is *jaundice*, which is nearly always present; in poisoning by mercury or arsenic it is never seen. A purple line has been observed round the gums a short time after the swallowing of the poison; in malachite workers a green line has been seen. Sulphate *of copper has been* used for producing criminal abortion.

Chronic poisoning is not very uncommon, in consequence of the many uses to which copper is applied. The premonitory indications are languor and giddiness, headache, constant thirst, loss of appetite, and a continual metallic taste in the mouth. After a time, extreme muscular weakness, constant nausea, and the passage of loose motions of a dark colour set in, but severe colic and local paralysis are rare. A kind of jaundice and free sweatings of a greenish colour, staining the patient's shirt, are early symptoms; green or bronzed stains on the teeth, a green line round the gums, and a peculiar characteristic retraction of the gums, the edges of which are of a purple colour, have been observed. The hair is stated sometimes to turn of a green tint, and a vesicular eruption about the roots of the hairs on the pubes has not unfrequently been seen.

Treatment.—Vomiting should be encouraged by draughts of warm water, and, if necessary, the stomach-pump may be employed. Albumen (white of egg) and milk, mixed with sugar, should be administered freely. With albumen, copper forms an insoluble albuminate, upon which very little action is exerted by the acid juices of the stomach.

In chronic poisoning, all treatment is unavailing until the cause of the mischief is got rid of.

Post-mortem Appearances.—The surface of the body will present a distinct yellow tinge. The contents of the stomach and intestines are generally of a greenish-blue colour, and yield a deep blue colour on touching them with liquor ammoniæ. The mucous membranes of the intestines and stomach are generally thickened and inflamed, and those of the latter organ softened, or ulcerated, or even gangrenous. Perforations have been found in the small intestines, peritonitis being set up by the escape of their contents. Ulceration has been found in the rectum, and in most cases the lungs are congested.

Quantity Required to Destroy Life.—Variable. One ounce of the sulphate has caused death, and recovery has occurred after an ounce, or even more.

Period at which Death takes place.—Variable. A fatal result has occurred in four hours; but, on the other hand, it has been protracted for three days.

Mode of Extraction from the Stomach.—Organic liquids in which copper is present are usually of a blueish-green colour

A. The contents of the stomach should be diluted with water. Hydrochloric acid should then be added, and, after being shaken, the mixture should be filtered.

Sulphuretted hydrogen must be passed through the clear filtrate, the copper being precipitated as sulphide (blackish-brown). The precipitate should be collected and nitric acid added in order to form nitrate of copper, which may then be tested in the usual manner. If there be plenty of the copper solution, a portion may be tested by placing in it a clean steel needle, and letting it remain in it for some time. The needle will then be coated by red metallic copper. This should be tested for copper, since a mere reddish deposit is difficult to distinguish from that due to the formation of a little iron peroxide.

B. A platinum crucible may be taken, and a small portion of the concentrated copper solution placed in it. Into this a few strips of zinc should be placed, and a drop or two of sulphuric acid added, the whole being then boiled. Wherever the zinc touches the platinum, spots of metallic copper are deposited. These may be dissolved off in nitric acid, and the resulting solution of nitrate of copper tested in the usual way.

Tests for the Copper Compounds:—(1) Liquor potassæ gives a pale blue precipitate (hydrated oxide of copper), turning black (the peroxide) on boiling. (2) Liquor ammoniæ (a few drops of) gives a pale blue precipitate, which is dissolved in excess of ammonia, forming a beautiful *sapphire-blue* solution. (3) Yellow prussiate of potassium gives a chocolate precipitate (ferrocyanide of copper). (4) Sulphuretted hydrogen and the clean steel needle tests described previously.

ZINC. ZINCUM.

All the salts of zinc are poisonous, although certainly not nearly so much so as those of copper and lead. The only preparations requiring notice are the sulphate (white vitriol or white copperas) and the chloride, which is contained in Burnett's fluid.

Symptoms of Poisoning.—There is a peculiar disagreeable metallic taste, vomiting of matters mixed with blood, severe pain in the abdomen, with purging, burning pain in the gullet, the pulse very feeble, the body very cold, the countenance anxious, but the faculties clear. In some cases there has been no vomiting. Chloride of zinc exercises a severe corrosive action upon the mucous membranes. Froth will probably issue from the mouth, and both voice and sight may be lost. The nervous system may suffer considerably. The primary symptoms may, however, be recovered from, but they may often recur, and produce death by secondary causes, such as stricture of the œsophagus or pylorus, or by the chemical action of the poison on the mucous membrane of the stomach.

Treatment.—This is similar to that of copper poisoning. Opium may be given to relieve pain, but when chloride of zinc has been taken, carbonate of sodium, tea, milk, white of egg and decoction of bark are the indications.

Quantity Required to Destroy Life.—One ounce of sulphate of zinc, or 100 grains of the chloride of zinc, may be considered a poisonous dose. Use may, however, induce great tolerance. It is stated that 120 grains of the acetate have been taken daily in a case of epilepsy.

Post-mortem Appearances.—When the sulphate of zinc is the poison, inflammation of the intestinal tract is constantly found

The lungs and brain are usually congested. The chloride produces the appearances of a corrosive poison.

The various internal organs have sometimes been found in a state of fatty degeneration. It must be borne in mind that zinc may have been given as an emetic. If discovered, it should not prevent other poisons being looked for. The stomach-contents should be boiled with acetic acid, in order to dissolve any zinc oxides existing in combination with animal matters. The liquid should be filtered, and through the filtrate sulphide of ammonium should be passed. The precipitate, which consists of sulphide of zinc, should be collected and dried, then acted upon by strong nitric acid, and diluted with sufficient water; after neutralising with carbonate of ammonium, the appropriate tests may be applied.

Tests for the Zinc Salts:—

(1) Sulphuretted hydrogen gives a *white* precipitate in neutral solutions; none in acid solutions. This is the only white precipitate given with a metal by sulphuretted hydrogen. (2) Ferrocyanide of potassium gives a white precipitate. (3) Sodium carbonate, charcoal, and the blow-pipe give yellow (zinc-oxide), which becomes white on cooling; the white crust, heated with cobalt nitrate in the outer flame of the blow-pipe, acquires a fine green colour.

IRON. FERRUM.

In a toxicological sense, the most important salts of iron are the ferrous sulphate (green vitriol or copperas), and the ferric chloride.

Symptoms of Poisoning.—None of the iron salts are active poisons, but they have been employed on several occasions with the intent to procure criminal abortion. The symptoms are those which would be induced by an overdose of an irritant poison, accompanied by pain in the stomach, violent purging and vomiting of an inky fluid.

Treatment.—This should consist in the use of the stomach-pump, emetics if required, and diluents with alkaline carbonates.

Post-mortem Appearances.—Those of a pure irritant. A quantity of black fluid will probably be found throughout the whole length of the stomach and bowels.

Mode of Extraction from the Stomach.—The organic matters should be digested thoroughly with water which has been acidulated by acetic acid. They should then be filtered, and the filtrate evaporated to dryness. The residue is then incinerated, and the ash dissolved in diluted sulphuric acid; the solution should then be treated with the appropriate tests.

Tests for the Iron Salts—

For the *Ferrous* salts:

These are of a *light-green* colour, and in solution give—(1) With alkalies, a white precipitate turning rapidly *greenish-brown*. (2) With ferrocyanide of potassium (*yellow* prussiate of potassium),

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a white precipitate passing through *light blue* to dark blue. (3) With ferricyanide of potassium (*red* prussiate of potassium), a *dark blue* precipitate (4) With sulphuretted hydrogen, no precipitate. (5) With sulphide of ammonium, a black precipitate. (6) With sulphocyanide of potassium, no precipitate. (7) With tincture of galls, no precipitate.

For the *Ferric* salts:

These are of a *reddish-brown* colour, and in solution give—(1) With alkalies, a *foxy-red* precipitate. (2) With ferrocyanide of potassium, a *Prussian blue* precipitate. (3) With ferricyanide of potassium, no special precipitate, but usually a green colour. (4) With sulphuretted hydrogen, a precipitate of sulphur (white), and the ferric salts are converted into the ferrous. (5) With sulphocyanide of potassium, a *blood-red* precipitate.. (6) With tincture of galls, a blueish-black precipitate.

TIN. STANNUM.

The only compounds of interest medico-legally are the chlorides.

Symptoms and Treatment of Poisoning.—The salts of tin act as irritant poisons. The treatment should consist of solution of carbonate of ammonium, milk and white of egg being administered in large quantities. Emetics should be used to encourage vomiting.

Mode of Extraction from the Stomach.—The organic fluids and tissues should be boiled in water for some time, acidulated with hydrochloric acid, the solution being then filtered, and the filtrate tested.

Tests for the Tin Salts—

For the *Stannous* salts: (1) Sulphuretted hydrogen gives a dark brown precipitate. (2) Gold chloride gives a beautiful purple precipitate, the "*purple of Cassius.*" (3) Solutions of the fixed alkalies give a white precipitate, soluble in excess. On boiling the solution, some of the tin is re-precipitated as black stannous oxide.

For the *Stannic* salts: (1) Sulphuretted hydrogen gives a yellow precipitate. (2) Gold chloride gives *no* precipitate. (3) Solutions of the fixed alkalies give a white precipitate of stannic acid, soluble in excess of alkali, but not re-precipitated on boiling.

SILVER. ARGENTUM.

Symptoms.—The only important salt medico-legally is the nitrate. No detailed cases of poisoning by this substance are on record, but from experiments on animals, it would seem that it acts as an irritant and corrosive poison.

The free absorption of the salt is shown by the blueness of skin, which is produced by the action of nitrate of silver. The colour is caused by the reduction of the metal, and its being deposited on the surface of the true skin. To occasion this action, however, the drug must be taken for some considerable period.

Treatment.—Common salt or chloride of ammonium in solution should be exhibited freely, vomiting should be encouraged, and albumen or white of egg should be given.

Post-mortem Appearances.—In cases of slow poisoning, the body will present a blue tint. When death has occurred rapidly from a large dose, a blue line will sometimes be seen around the gums, the intestines and stomach being either of an intense red colour (inflamed), or white from the action of the salt, or black from the decomposition of animal matters.

Mode of Extraction from the Stomach.—The contents should be boiled with bicarbonate of potassium, and filtered. The residue should then be boiled with nitro-hydrochloric acid, and again filtered. The filtrates should be mixed together and evaporated to dryness, in order to char the organic matters The residue should be redissolved in diluted nitric acid, and saturated with ammonia. Filtration should be performed, and the silver precipitated with hydrochloric acid, in a solution again acidified with nitric acid.

Tests for the Silver Compounds.—(1) Hydrochloric acid gives a *white* precipitate *soluble* in liquor ammoniæ. (2) Alkalies give a *brown* precipitate soluble in excess of liquor ammoniæ. (3) Sulphuretted hydrogen gives a black precipitate insoluble in sulphide of ammonium. (4) Iron, copper, and mercury precipitate the metal *white*. (5) Chromate or bichromate of potassium gives a *brown* precipitate. (6) Tribasic phosphate of sodium gives a *yellow* precipitate.

BISMUTH.

Symptoms.—Nitrate of bismuth acts as an irritant poison, but since it is frequently contaminated with carbonate of lead and arsenic, this fact may account for many of the symptoms which have been ascribed to its agency.

Tests for the Bismuth Compounds.—(1) Sulphuretted hydrogen gives a black precipitate. (2) Solutions of these salts become *milky* upon the addition of water, insoluble basic compounds being formed. (3) Metallic bismuth is easily reduced from its compounds before the blow-pipe as a brittle bead.

MANGANESE.

Symptoms.—The salts of manganese act as feeble poisons. It has been stated, on the one hand, that they act as insidious poisons, and induce paraplegia, whilst, on the other hand, it is said that an ounce of sulphate of manganese is a safe laxative.

Tests for the Manganesium Compounds.—(1) The alkalies give *white* precipitates, becoming *brown*. (2) Sulphide of ammonium gives a *flesh-coloured* sulphide. (3) With borax bead before the blow-pipe, the salts form an amethyst-red in the outer flame, and a colourless one in the inner. 4. These salts when heated upon platinum foil with carbonate of sodium, yield a *blueish-green opaque bead* of sodium manganate.

CHROMIUM.

The most important salt of chromium is the bichromate of potassium, which is largely used for dyeing purposes.

Symptoms of Acute Poisoning.—Those of a powerful irritant. There are generally violent and constant purging, the stools being of a peculiar clay colour, and the vomited matters yellowish. The pupils are dilated. There are severe cramps in the legs, and extreme general depression. The urine may be entirely suppressed, or scanty and purulent.

There are usually swelling and pain of the periosteum.

The poisonous action is specially marked upon the mucous membranes.

Post-mortem Appearances.—Those of an irritant poison. The mucous membrane of the stomach is inflamed and destroyed, or marked with patches of dark red discoloration; the blood is black and thin.

In some cases, however, there have been no well-marked appearances.

Treatment.—Emetics should be given freely, and carbonate of magnesium, lime, or milk, should be exhibited.

In **Chronic** poisoning, there will be a bitter, nauseous taste in the mouth, great irritation of the mucous membrane of the nose, incessant sneezing, increased lacrymation, and sometimes severe conjunctivitis. Finally, the mucous membrane ulcerates, and the septum nasi may become destroyed. A common symptom is the presence of chronic sores on the hands, feet, and shoulders, forming immediately there is any lesion of the skin.

Quantity Required to Destroy Life.—Two drachms have proved fatal in four hours, whereas recovery is recorded after a dose of two ounces.

Treatment.—The throat should be sponged with nitrate of silver, and internally small doses of corrosive sublimate may be given.

Mode of Extraction from the Stomach.—The red colour of the solution is some guide to its presence, but this may have become greenish from the reduction of the chromic acid by the organic matter. The stomach and its contents should be digested with hydrochloric acid, then boiled and filtered, and the filtrate tested.

Tests for the Chromium Compounds.—

For the *Chromous* salts:—(1) Sulphide of ammonium gives a black precipitate. (2) Liquor ammoniæ gives a blue precipitate, turning green.

For the *Chromic* salts:—(1) Sulphide of ammonium gives a greyish-green precipitate. (2) Liquor ammoniæ gives a *greyish-green precipitate.* (3) Silver salts give crimson precipitates.

All the salts of chromium yield with the borax bead and the blowpipe an emerald-green glass in the reducing flame.

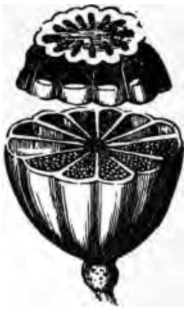
ORGANIC POISONS.

NARCOTICS.

OPIUM AND ITS PREPARATIONS.

Papaver Somniferum. The White, Garden or Opium Poppy.

Fig. 110.



Papaver Somniferum. Capsule of the Opium Poppy.

In addition to the many preparations of opium used in legitimate medicine, there are many patent remedies containing this drug, or its alkaloid **morphina**, and all of which have proved fatal, such as black drop, Godfrey's cordial, Dalby's carminative, Winslow's soothing syrup, Locock's pulmonic wafers, chlorodyne, nepenthe, liquor opii sedativus (Battley), syrup of poppies, &c. The white poppy-heads grown in this country are also poisonous. Fig. 110 shows the capsule of the opium poppy.

Opium contains several principles, but medico-legally morphina and meconic acid (combined in the drug itself as meconate of morphina) are the most important, and by the reactions of these two substances the presence of opium is recognised.

Symptoms of Poisoning. — These are giddiness, drowsiness, followed by stupor, proceeding to perfect unconsciousness, profound sleep, slow and almost imperceptible breathing, eyes shut, pupils contracted and insensible to light, pulse very rapid and small, or full and slow, skin moist and cool, and the face flushed. At first the patient can be roused by a loud noise, but at a later stage he is kept awake with the greatest difficulty, and at last he becomes completely comatose, with stertor, pallor, and ghastly countenance. Death may take place from apoplexy, collapse, apnœa, convulsions, or paralysis, but it is usually tranquil.

In rare cases there are vomiting, diarrhœa, delirium, tetanoid spasms, dilated pupils, and it has happened that the usual narcotic symptoms have been absent, and death has occurred suddenly.

When the drug is taken in large quantity, and in a fluid state, the symptoms may commence within a few minutes, and coma may be established in half an hour. Complete stupor has been present within fifteen minutes, even when the poison has been taken in a solid form; but, nevertheless, the action of a large dose of opium may be delayed for half-an-hour or more, and even eighteen hours have elapsed before the development of symptoms. When the stomach is full, the action of the poison is more rapid than when the organ is empty, and it is more active when taken in a liquid form than when in a solid state: or when the patient remains still, than when he moves about.

Treatment.—Get rid of the poison as quickly as possible. The stomach-pump may be used; infusion of green tea, coffee, or water with finely powdered charcoal suspended in it, being employed to wash out the stomach. Vomiting should be encouraged by emetics, as sulphate of zinc, and by tickling the fauces with a feather. A free purge may be given after the emetic has acted. The patient should never be allowed to sleep, but kept continually moving. Cold water may be thrown on the face and neck, and strong tea and coffee given at repeated intervals. Tannic acid is considered by some to be the only antidote. As regards the employment of belladonna preparations as antidotal to opium, it has been stated that these are worse than useless, as the presence of both poisons increases the effect of either.

Post-mortem Appearances.—These are not well marked or constant. The most frequent are a turgid state of the cerebral vessels, with or without effusion of serum under the arachnoid, into the ventricles, at the base of the brain, or around the spinal cord.

Quantity Required to Destroy Life.—The smallest recorded is about four grains, but enormous quantities have been taken without ill effects. In young children remarkably small doses have proved fatal, and some persons are peculiarly susceptible to the influence of opium, others just the reverse.

If large quantities of opium are taken habitually, and for a long period, they are followed by emaciation, loss of appetite, with constipation and loss of mental and physical vigour, severe neuralgic pains, premature old age, and early death.

Period at which Death takes place.—The shortest recorded is three-quarters of an hour. The average may be said to be seven to twelve hours. If the case survives for twelve hours, the hope of recovery is very good.

Mode of Extraction from the Stomach.—The odour of opium may be detected in the stomach. Every watery solution of opium contains *meconate of morphina.* The process is as follows:—The contents of the stomach should be filtered, any solid matters being cut into small fragments, and well mixed with the liquid. Acetic acid should be added, and then acetate of lead; by this means meconate of lead is precipitated, and acetate of morphina remains in solution. The mixture is filtered and tested as follows:—The solution containing the acetate of morphina is divided into two portions. To the one is added solution of perchloride of iron, upon which a greenish-blue colour is produced. The other is evaporated to dryness, and nitric acid added, when a yellow colour, passing to orange red, is developed. The precipitate containing meconate of lead is diffused through water, and through it sulphuretted hydrogen passed, by which means sulphide of lead (black) is precipitated, and a solution left containing meconic acid. In this last, upon the addition of perchloride of iron, a blood-red solution is formed.* It must, however, be mentioned that this method of analysis will sometimes fail, and in some cases of poisoning by opium the best methods of analysis have afforded no satisfactory evidence of the presence of the poison.

Tests.—1. **Nitric Acid,** added to dry morphina, developes a rich orange colour, dissolving the morphina with effervescence, and with the production of ruddy fumes. If the acid is added to a solution of morphina, a yellow colour is produced.

2. **Perchloride of Iron.**—This re-agent, which should be neutral, gives a rich indigo blue with powdered morphina, turning to green if added in excess. With a solution of morphine the colour produced is greenish blue.

3. **Starch and Iodic Acid.**—A small quantity of iodic acid is dissolved in a drop of cold, freshly made starch, and placed on a white slab, morphina being then added. The iodine is liberated upon the starch, and the blue iodide of amiden or farina produced.

4. **Sulphuric Acid and Bichromate of Potassium.**—Sulphuric acid, when added to morphina, produces but little effect, but upon the addition of solution of bichromate of potassium, the mixture becomes of a rich brown hue, which rapidly passes to green, due to the reduction of the green oxide of chromium.

For **Meconic Acid** the only reliable test is the perchloride of iron, which yields with it a blood-red or intense cherry-red colour, discharged by a solution of protochloride of tin, but not by solution of chloride of gold, or perchloride of mercury, or by diluted mineral acids. Although it is true that perchloride of iron gives a similar red reaction with sulphocyanide of potassium, the alkaline acetates, and common mustard, still the successful action of this test for meconic acid is strongly confirmatory of the presence of opium, when the tests for morphina have been satisfactorily obtained.

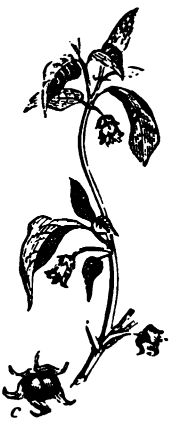
DELIRIANTS.

ATROPA BELLADONNA. THE DEADLY NIGHTSHADE

contains an alkaloid **atropina,** probably combined with malic acid as malate of atropina. Fig. 111 shows the belladonna plant with its campanulate corolla, which is dull purple on the border. At *c* is shown the berry, which is shining, violet black, globose, the size of a small cherry, and two-celled. The symptoms of poisoning by belladonna and its alkaloid are identical, with the exception that, with atropina, they are more intense, and begin earlier.

With belladonna the symptoms usually commence in from one and a-half to two hours, but have been protracted for five hours, and, on the other hand, they have appeared within twenty minutes. They are only liable to be mistaken for those of poisoning by stramonium and hyoscyamus. There are drowsiness, giddiness, intense thirst, dryness of the throat and mouth, the saliva being suppressed, and difficulty of swallowing (dysphagia). Purging is rare. and vomiting only occasional. The heart's action is increased, the pulse abnormally rapid and strong The face is flushed, the eyes are sparkling and prominent; possibly there may be some congestion of the conjunctiva, and *invariably wide dilatation of the pupils*, the dilated condition remaining after the recovery of the patient. An early symptom is loss of speech, with constant movement of tongue and lips, as if attempting to make utterance; possibly, also loss of sight, or indistinct and double vision, due to absence of the power of adjustment. There is usually a desire to micturate, with inability to do so. Other symptoms are numbness of the extremities, with partial paralysis, staggering as if drunk, leading to delirium, which is occasionally of a furious and maniacal character, but more frequently of a pleasing nature, the patient bursting into fits of uproarious laughter. All kinds of hallucination, false images, and spectral illusions may develop themselves.

FIG. 111.



Atropa Belladonna.
c. The Berry.

Other symptoms recorded have been, sneezing, lock-jaw, the urine either discharged involuntarily or entirely suppressed, hæmaturia, and, in many instances, an eruption like that of scarlatina.

Treatment.—Emetics should first be given, and tannic acid, animal charcoal, and iodine in iodide of potassium have been recommended, but if these are given it will be necessary afterwards to use the stomach-pump, in order to clear the stomach. It has been asserted that opium is the chemical antidote for belladonna, but this is hardly borne out by experiments. It is true that the pupil is contracted by opium and dilated by belladonna. But here their antagonism seems to end. Opium is undoubtedly useful in the stage of delirium, but it must not be trusted as a chemical antidote. Hypodermically a one-fifth grain of morphina is the best mode of exhibition, in order to tranquillise the patient. As soon as the sufferer is somewhat better, it will be advantageous to give a good dose of castor oil and strong coffee.

Post-mortem Appearances.—These are usually not well marked. The chief points are the dilated pupils and brilliant eyes. There is generally congestion of the brain. Inflammation of the stomach may or may not be present. Careful search should be made for any seeds of the berries, and any possible staining of the tissues by the juice.

Period at which Death takes place.—Death from a case of belladonna-poisoning is comparatively rare, since the patient, after a time, falls into a deep sleep, from which he awakes better, and is perfectly unconscious of all that has taken place; but, when death does take place, it usually occurs within fifteen or sixteen hours.

Quantity Required to Destroy Life.—Death has resulted from a few ripe berries, from the injection of a decoction of 80 grains of the root, and from a drachm of the extract. Two of the berries and three grains of the extract have caused bad symptoms. Recovery has, however, taken place after as many as fifty berries, after even two or three drachms of the extract, and an infusion of two drachms of the leaves. The external application of a belladonna plaster has been said to cause death. Two grains of atropina have caused death, and recovery is recorded after 1·5 grains. The application of an ointment of atropina has also produced a fatal result. The admixture of strychnine with belladonna is said largely to influence the activity of the latter.

Mode of Extraction from the Stomach.—An attempt should be made to find any leaves or seeds of the plant, since these afford the strongest evidence of the cause of death. Frequently the stomach is stained by the colour of the fluid of the berries, and this colour is changed to red by acids, and green by alkalies. The alkaloid atropina may be recovered by the same process as that employed in the discovery of aconitina.

The physiological tests are the most important, and notice should always be taken of the action of the residue when dropped into the eye or injected under the skin of a rabbit. Henbane and stramonium will, to a certain extent, although in less degree, cause a similar result.

Tests for Atropina.—1. A solution of hydrobromic acid, saturated with free bromine, gives a *yellow* precipitate, which rapidly becomes crystalline, insoluble in acetic acid, or in mineral acids, or in caustic alkalies.

2. A solution of iodine in iodide of potassium gives a *reddish-brown* precipitate, insoluble in potash or in acetic acid.

3. Chloride of gold gives a *citron-yellow* precipitate, insoluble in potash, and sparingly soluble in acids.

HYOSCYAMUS NIGER. THE HENBANE.

This plant contains an alkaloid, **hyoscyamina.**

Symptoms come on somewhat suddenly from a few minutes to half an hour after the reception of the poison. There may be a little excitement, giddiness, pains in the head, flushed face, rapid, full pulse, succeeded by laboured breathing, incoherent talk or loss of power to talk, sight becoming indistinct, perverted, or quite destroyed. Later there is loss of power in the legs, with shaking of the limbs, and tetanoid movements of the muscles. Two effects are constant—viz., dilated pupils and uncontrollable delirium, usually very violent, either alternating with or terminating in coma.

Occasional symptoms have been dryness of throat, diarrhœa and vomiting, and a scarlet eruption on the skin.

The seeds and root have both proved poisonous at times, varying from a few hours to some days, but recovery has taken place in most instances.

Treatment.—The same as that of belladonna-poisoning.

Post-mortem Appearances.—Nothing more than congestion of the brain and its membranes.

Mode of Extraction from the Stomach.—The chief point is to find portions of the leaves, or of the seeds. It is almost impossible to isolate the alkaloid, but important evidence would be yielded if a residue were obtained which, when applied to the eye of a cat, produced dilatation of the pupil.

The **Solanum tuberosum** (the potato), **Solanum nigrum** (the black nightshade), the **Solanum dulcamara** (the woody nightshade or bitter-sweet), are possessed of poisonous properties, residing chiefly in the leaves and berries. They occasion symptoms such as dimness of sight, giddiness, delirium, trembling of the limbs, purging and vomiting, with dilatation of the pupils.

DATURA STRAMONIUM. THE THORN-APPLE.

This plant contains an alkaloid, **daturina,** which is considered by some to be identical with atropina.

Symptoms of Poisoning.—These are similar to those of belladonna and hyoscyamus, but they set in somewhat sooner and are more severe. There are, ringing in the ears, dryness of throat, and flushed countenance, the pupils always *widely dilated,* violent delirium, with double vision; spectral illusions ensue rapidly, and generally terminate in intense coma. The lower extremities are often paralysed, and there is occasional irritation of the alimentary canal. The skin has been the seat of a scarlet eruption. Most cases recover.

Death has resulted in seven hours in one case, and in twenty-four in another.

Treatment.—The same as in belladonna-poisoning. Emetics, stomach-pump and castor oil. A few leeches to the temples, if the face is much flushed.

Post-mortem Appearances.—The most important and prominent appearance is congestion of the brain and its membranes. **Irritation of the stomach** has been found occasionally.

Mode of Extraction from the Stomach.—Finding parts of plant is the most conclusive. An attempt may be made to extract the alkaloid, but this is extremely difficult.

COCCULUS INDICUS.

This is the berry of the **Menispermum** or **Anamirta Cocculus.** An extract of the berries is used for poisoning fish, and it is also employed to give an intoxicating quality to beer and spirits. It contains a poisonous alkaloid, called **picrotoxine.**

Symptoms.—Gastro-intestinal irritation with lethargic stupor and powerlessness.

Picrotoxine appears in colourless prismatic crystals, having an intensely bitter taste. An alkaline solution, when treated with sulphate of copper, deposits the oxide of copper. The picrotoxine may be obtained from the stomach by Stas's process.

SOLANUM NIGRUM. THE BLACK OR GARDEN NIGHTSHADE.

The flowers are small and white, and the berries when ripe are black. The flowers and berries have been eaten by children and have given rise to intestinal irritation and cerebral symptoms, the pupils being extremely dilated.

LOLIUM TEMULENTUM. THE DARNEL.

The seeds of this plant are sometimes ground into flour for making bread or mixed with other grains employed for distillation. They may occasion symptoms of intoxication with heat of throat, headache, giddiness, staggering, impaired vision, trembling of the limbs, vomiting, and collapse.

CAMPHOR. CINNAMOMUM CAMPHORA.

Symptoms.—The usual effects of an overdose of camphor are giddiness, cramps, imperfect sight, numbness of the extremities, apparent intoxication, difficulty of breathing, thirst, and at times convulsions. Recovery is usually preceded by long deep sleep, in which there is profuse sweating, the patient awakening intensely exhausted. The odour of camphor may be observed in the breath.

Thirty grains proved fatal in seven hours to a child one and a half years of age. Severe effects have followed small doses, although it is on record that doses of 90 grains, repeated four times daily, have not been followed by bad results.

Post-mortem Appearances.—There is usually injection of the membranes of the brain, the bowels and stomach are inflamed. and the genito-urinary tract much congested.

Treatment.—Emetics should be given, followed by a full dose of castor oil.

Upon examination after death, all the parts should be examined carefully for the camphor odour, and search should be made for undissolved portions of the poison. Strong alcohol should be added to the soluble contents, which should be then filtered; upon the addition of water to the alcoholic solution, the camphor will be precipitated.

POISONOUS FUNGI.

Many fungi are eaten all over the world with impunity, but others are of doubtful character. One individual may eat them without injury, while, in another, a mere taste may occasion violent poisonous symptoms. Some fungi, however, are uniformly productive of alarming results.

It may be stated generally that all fungi which grow in marshy situations, smell offensively, have a warty cap, and a green or scarlet hue, or turn blue very soon after being cut, or are burning to the throat, and have a bitter taste, should be regarded with suspicion.

The time at which the symptoms commence is very variable, since the same fungus will act differently on different persons. The symptoms have begun in ten minutes, or have been delayed for thirty-six hours.

Fungi frequently act as *narcotics*, intense coma being a prominent indication. Sometimes they act as *irritants*, inducing vomiting, pain, and purging; at other times they act as *irritants* and *narcotics;* headache, giddiness, dimness of sight, illusions, delirium, and convulsions are common symptoms. The same fungus may induce narcotic symptoms in one member of a family, and irritant symptoms in another.

Many cases recover, especially when vomiting has been early. One case is on record in which a man suffered for a year, more or less. Death generally takes place within twenty-four hours, but may be delayed for two or three days.

The circumstances which modify the action of fungi are the following:—

(*a*) *Idiosyncrasy.*—To some persons all forms of fungus are injurious.

(*b*) *Cooking.*—The active principle of a poisonous mushroom is thought to be volatile, and dissipated by moderate heat. Boiling in water, or soaking the mushroom, cut into slices, in vinegar or brine, may, to some extent, eliminate this principle.

(*c*) *Climate.*—Many are eaten in France which in England are considered poisonous; and some are commonly eaten in Russia and Prussia which are never eaten in France.

It is stated by Braconnot that fungi contain various principles consisting mainly of an acrid resin, a saccharine substance, and a spongy principle termed fungin; whilst Letellier thinks there are two active principles, viz.:—

(*a*) *An acrid volatile principle*, to which the irritant properties may be ascribed, and which, from its volatility, disappears upon drying or boiling the fungus in water.

(*b*) An alkaloid, **amanitine, to which the narcotic symptoms are attributable.**

Treatment.—The stomach-pump should be used, and emetics of sulphate of zinc and castor oil given.

There is no chemical antidote.

Post-mortem Appearances.—The stomach and intestines are frequently the seat of intense inflammation, and may be even gangrenous. Usually the liver is enlarged, and the vessels of the brain much congested.

Detection.—Endeavours should be made to find portions of the mushroom, and then the gills scraped, and examined microscopically for spores. The discovery of *pink irregular spores*, entoloma or *rusty brown irregular spores*, hebeloma or of *round white prickly spores*, russula, lactarii would afford strong indications of the presence of a poisonous mushroom. A complete analysis should always be made, in case the mushroom may have been the vehicle for the criminal administration of some poison, in order to disarm suspicion.

DEPRESSANTS.

TOBACCO. NICOTIANA TABACUM.

The whole of the tobacco plant contains an alkaloid, **nicotina**, united to malic and citric acids, as malate and citrate of nicotina, and also tobacco camphor or nicotianin, a concrete volatile oil. It has been stated that these principles are present in whatever form tobacco is taken. In French samples of tobacco about 7 to 8 per cent. of nicotine are present. The Kentucky and Virginia tobaccos contain from 6 to 7 per cent. In Havannah tobacco, not more than 2 per cent. is present.

Symptoms of Poisoning.—Tobacco is essentially a powerful sedative. There are confusion and giddiness, tremblings of the limbs, much depression and faintness, with anxious countenance and cold clammy sweats, frequently vomiting, and occasionally purging, accompanied by violent pains in the abdomen. The pulse gradually becomes very weak and quivering, and sometimes hardly perceptible; the breathing more and more difficult, vision is impaired, and death is ushered in with convulsions more or less severe, and paralysis more or less perfect. The state of the pupil varies, being sometimes natural, sometimes contracted, and sometimes dilated; more often the last.

Treatment.—Vomiting should be produced as soon as possible by means of emetics, or the stomach-pump should be used, animal charcoal at the same time being injected into the stomach. Pain should be relieved afterwards by opium, and stimulants should be given.

Post-mortem Appearances.—These are not characteristic. There is generally congestion of the stomach, the vessels of the brain, lungs and liver being filled with black blood, and the heart empty. The blood is generally liquid, but black and resembling treacle. Nicotine should be looked for in the lungs, liver and stomach.

Quantity Required to Destroy Life.—The external application of a decoction of tobacco for a skin affection has proved fatal, as well as half a drachm used as an injection. The application of tobacco-leaves to the skin has produced death, whereas recovery is recorded after the injection of an infusion of five leaves and half an ounce of snuff.

Period at which Death takes place.—Symptoms commence quickly and end rapidly. Death has resulted from nicotine in three minutes; and with tobacco in fifteen minutes.

Mode of Extraction from the Stomach.—Pieces of tobacco should be looked for with a lens and examined microscopically. Their peculiarity consists in the hairs found on them. The organic liquid should be digested with water acidified with acetic acid, filtered, and the filtrate treated with acetate of lead; again filtered, and the excess of lead precipitated by sulphuretted hydrogen, the black lead sulphide being filtered off. The filtrate should be treated with caustic potash, the clear supernatant fluid being poured off and then distilled, after which a fluid with the odour and reactions of nicotine will be yielded. The action of the residue should be tried upon small birds; or on a rabbit if there be sufficient; the usual symptoms being immediate disorder of the respiration, vomiting, tremors, loss of muscular power, convulsions and stupor.

Tests for Nicotine.—(1.) The odour is characteristic. (2.) *Corrosive sublimate* yields a white crystalline precipitate, changing to yellow, and soluble in acetic and hydrochloric acids. This is a very delicate test. It must be remembered that corrosive sublimate gives a precipitate with most alkaloids, but this precipitate is almost always amorphous. With strychnine the precipitate is crystalline, but it is nearly insoluble in acetic acid.

SMOKING.

Tobacco in every form is a poison. Death has resulted from excessive smoking, and hard smoking has led to paralysis of the portio dura, whilst dyspepsia and extreme nervous symptoms are common results. Perhaps in moderation tobacco may have a soothing influence, but there can be no possible doubt that its excessive use may lead to a train of miserable symptoms. Blindness, or tobacco-amaurosis, has been stated to be caused by it. Some discussion has taken place with respect to the active agent in tobacco-smoke. By some authors it is regarded as a product of the decomposition of the nicotine, and not the nicotine itself, since the presence of this alkaloid in the smoke has been disputed.

Some say, however, that the harmful effects are due to the vapours of cyanide and sulphide of ammonium, and these substances have been stated to be invariably present, more or less, in tobacco-smoke. According to Eulenberg and Vohl, no nicotine was found in tobacco-smoke even when the tobacco employed contained 4 per cent. In their analysis the evolved gases consisted of oxygen, nitrogen, carbonic anhydride, sulphuretted hydrogen, and marsh gas, in company with various bases, but not the smallest trace of nicotine. They consider that the bases of a substance termed pyridine are responsible for the injurious effects of smoking.

Heubel, of Kien, however, asserts that nicotine is present in the smoke of tobacco as a salt of the alkaloid, and especially when the combustion is not very rapid. Also that nicotine is present in tobacco as a stable salt of that alkaloid, and that the nicotine derived from the smoke of a single cigar will suffice to produce convulsions, paralysis, and death in a frog.

Death has been caused by snuff, and even the fact of sleeping among bales of tobacco-leaves has been stated to produce symptoms of poisoning. The effects produced upon work-people in tobacco-manufacture was the subject of inquiry by the Paris Academy of Medicine some years ago, and the following facts were obtained: When the workmen were first admitted, they suffered from headache and nausea, and frequently diarrhœa, symptoms which, as a rule, pass off in 8 to 15 days. The women suffered more than the men. When these people became acclimatised, they rarely suffered further, and appeared to be specially proof against ague, phthisis, neuralgia, scabies, and dysentery. In those who had been at work for at least two years, a peculiar grey tinge of skin was observed, showing that some distinct change was going on in the system. No nicotine was discovered upon analysing the urine and blood of these work-people, but the tobacco-emanations killed a rose-tree in the work-room. Finally, in a few exceptional cases, the bad symptoms were not overcome by time.

LOBELIA INFLATA. THE INDIAN TOBACCO

has been termed the emetic weed (Fig. 113), and contains an alkaloid lobelina, which somewhat resembles nicotine and conina. It gives with sulphomolybdic acid a deep yellow colour, after a time passing into brown and then into yellow. Lobelia is much employed in the treatment of asthma.

Symptoms.—Speedy vomiting, succeeded by distressing nausea, with headache and giddiness, copious cold sweats, tremor and extreme prostration.

Post-mortem Appearances.—Marked congestion of the cerebral vessels, and intense inflammation of the mucous membrane of the stomach.

Fatal Dose.—One drachm of the powdered leaves.

Fatal Period.—About 36 hours.

Treatment.—Draughts of warm water to promote vomiting, and also the free use of stimulants.

CONIUM MACULATUM. THE SPOTTED HEMLOCK

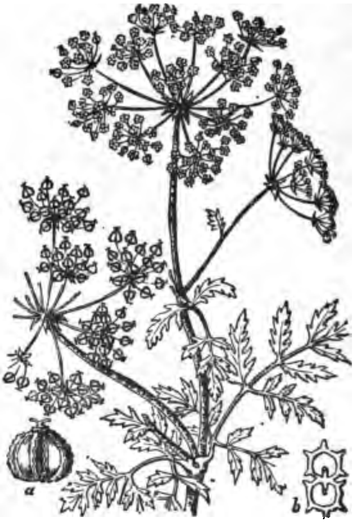
contains a poisonous alkaloid **conina**, which is a volatile oily fluid, having a mousy smell, and giving a greasy pink stain to filtering-paper. The Conium plant with its fruit is shown in Fig. 112.

Symptoms.—Dryness and constriction of the throat, great muscular prostration, pupils usually dilated, with confusion of vision, due to impaired adjustment of the eye-muscles. Eventually complete paralysis. Occasionally delirium, coma, and convulsions.

Post-mortem Appearances.—Those of asphyxia, the vessels of the brain congested and the mucous membrane of the stomach red.

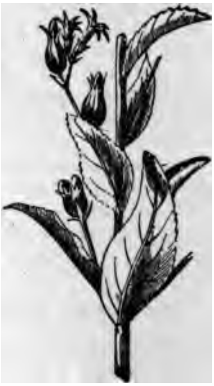
Treatment.—Emetics, diffusible stimulants, and subsequently artificial respiration.

FIG. 112.



Conium Maculatum. *a*. The fruit with its undulated crenated primary ridges; *b*. Transverse section of the fruit.

FIG. 113.



Lobelia Inflata.

PHYSOSTIGMA VENENOSUM. THE CALABAR BEAN.

This plant contains an alkaloid, **physostigmina** or **eserina.**

Symptoms.—There are giddiness, followed by paralysis of the voluntary muscles, frequently convulsive muscular twitchings, and invariably contraction of the pupils preceded by myopia. The mind usually remains clear. In fatal cases the muscles of respiration become affected, and the patient dies of asphyxia.

Bouchardat states that one drop of the extract of physostigmina applied to the eye of an animal produces contraction of the pupil in from 10 to 15 minutes. This symptom is of great diagnostic value as distinguishing the poison from conina, atropina, daturina, or hyoscyamina. The Calabar bean acts as a direct spinal depressant, and thus its action is physiologically the exact reverse of that of strychnina.

Six of the beans have proved fatal to a boy aged six.

Treatment.—The stomach-pump and emetics must be used. Since atropina produces dilatation of the pupil, it has been suggested to inject one-thirtieth of a grain of this alkaloid hypodermically, gradually increasing the dose until dilatation of the pupil is produced, but some of the most reliable authorities do not consider such treatment allowable.

Test.—1. The physiological test is the most important. The merest trace dropped into the eye of a rabbit, produces contraction of the pupil in from 10 to 15 minutes.

2. If to physostigmina dissolved in water some caustic alkali is added, the solution, on exposure to air, turns to a green or blue colour.

CONVULSIVES.

NUX VOMICA.

The symptoms of poisoning by the nux vomica seeds and their preparations are the same as those caused by strychnine. The seeds have a coating of silky light-brown hairs, which radiate from the centre, and are shown in Fig. 114 after treatment with nitric acid.

FIG. 114.

Nux Vomica. The brown silky fibres forming the coating of the nut and distinctly defined by heating with a drop of nitric acid.

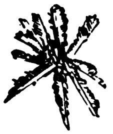
STRYCHNINA.

This alkaloid is largely used in different forms of "vermin-killers." "Battle's Vermin Killer" contains 23 per cent., Butler's contains about 5 per cent., and Gibson's about 5 grains in each powder. A case is on record in which 150 pheasants were poisoned through eating the maggots generated in some animal destroyed by a strychnina vermin-killer.

Symptoms of Poisoning.—These usually begin in from 10 to 20 minutes, but depend upon the form of administration, being more rapidly developed when the poison is taken in solution than when given in the form of a pill. There is a hot, bitter taste in the mouth, intense feeling of suffocation, the strychnina "fit" then comes on, with jerking of the muscles, great stiffness of the body, and tetanoid convulsions. The frequent form of the tetanoid spasm is opisthotonos (the body being arched upon the head and heels) Pain is intense from the muscular contractions. Vomiting is not common. There is constant gasping respiration, and the risus sardonicus (broad grin). The pupils are dilated during the fit. Then comes a remission, which may last from a few minutes to *half an hour*, and the pupils contract. The prominent symptom is trismus (locked-jaw), and this is frequently present, although the jaw is the last part affected. Hyperæsthesia is intense, the slightest touch causing a return of the paroxysms. The patient dies either from asphyxia, or from the extreme exhaustion, and the mind usually remains clear to the last.

Treatment.—The stomach-pump must be used, and powdered animal charcoal injected and allowed to remain in the stomach for five minutes, and then pumped out. Chloroform should be administered to overcome the trismus. To relieve thirst (if the patient can drink), the best remedy is strong tea. Numerous remedies have been advocated—viz., opium and morphina, nicotine, tannin, prussic acid, common salt, and chloral hydrate. The last is probably the most valuable drug.

FIG. 115.



Acetate of strychnina, to a weak solution of which the tests are supposed to be applied, crystallising in tufts of needles.

Post-mortem Appearances.—Little can be said. The special appearance is intense congestion of the brain and spinal cord, with considerable effusion of blood, but this is not constant. Post-mortem rigidity is usually prolonged.

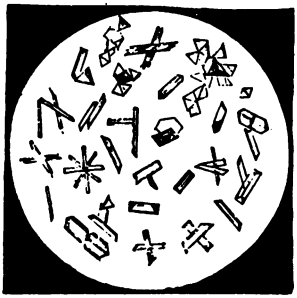
Quantity Required to Destroy Life.—$1\frac{1}{2}$ to 2 grains is a poisonous dose; $\frac{1}{12}$ of a grain has produced severe tetanus; and $\frac{1}{4}$ grain has proved fatal; even $\frac{1}{6}$ of a grain is regarded as poisonous. It must, however, be stated that recovery has taken place even after as much as 40 grains. The hypodermic injection of strychnina exercises a far more energetic action than when it is given by the mouth.

Period at which Death takes Place.—Death or recovery is always rapid, and the case is hopeful if the individual lives over five or six hours.

Mode of Extraction from the Stomach.—The organic mixture should be acidified with acetic acid, and diluted with sufficient water to make it filter easily, and the filtrate then evaporated to a thick syrup. This should be heated with eight or ten times its bulk of alcohol, again filtered, and the alcohol distilled off. The filtrate should be saturated with liquor potassæ, and shaken up with its own bulk of ether. Here the acetic acid combines with the strychnina to form acetate of strychnina (Fig. 115), the potash unites with the acetic acid to form acetate of potassium, and precipitates the strychnina, which is taken up by the ether. Sulphuric acid may be added during the operation, in order to remove colouring-matter. The above process is repeated two or three times, in order to ensure the perfect purity of the alkaloid.

Tests.—1. The intense bitter taste. 2. The physiological test. The solution injected under the skin of the back of a frog produces tetanic convulsions. It is stated that these convulsions have followed the injection of the $\frac{1}{18000}$ part of a grain into the lungs of a small frog. 3. The "colour test." If strychnina is placed on a white plate, and touched with a drop of strong sulphuric acid, no colour results, but a sulphate of strychnina is formed. A little peroxide of manganese or lead, or bichromate of potassium, is then stirred into the mixture, and a rainbow play of colours is exhibited. This result is due to the development of nascent oxygen upon the alkaloid. Dr. Letheby suggested the employment of the galvanic battery in the production of this play of colours, as follows:—Place a drop of solution of strychnina (one part in 15,000 or 20,000 of water) in a slight cup-shaped depression on platinum foil. Let the fluid evaporate, and then moisten the spot with strong sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's battery, and touch the acid with a platinum terminal from the negative pole. At once the violet colour will flash out, and, on the removal of the pole from the acid, the tint will remain.

FIG. 116.



Various forms of Crystals of Strychnina, as obtained from an alcoholic solution (magnified 124 diameters).

The microscopical appearances of crystals of strychnina are shown in Fig. 116.

BRUCINA.

This alkaloid, also found in the nux vomica, possesses properties similar to those of strychnina. Its activity is, however, far less. It requires $\frac{1}{100}$ of a grain of brucina to produce upon a frog the effects of $\frac{1}{1000}$ of a grain of strychnina. That is to say, brucina is 10 times less powerful than the last-named substance. The convulsions produced by brucina are neither so long in duration, nor so severe as those induced by strychnina.

To obtain brucina from organic mixtures, the same process as that for the recovery of strychnina may be used; and, in testing the residue, nitric acid should be first tried, and then the protochloride of tin.

Tests.—1. Nitric acid gives a brilliant red colour, changing to yellow on heating, and if, after warming, a trace of protochloride of tin is added, the colour becomes deep purple.

2. No action with nascent oxygen, but, if mixed with bichromate of potassium, and sulphuric acid added, an orange, then green, and lastly a yellow tint is produced, this action being dependent upon the reduction of the chromium salts.

ASPHYXIANTS.

CARBONIC ACID GAS.

The generation of carbonic acid gas takes place in many ways: such as by respiration, by fermentation, by the burning of lime, by the combustion of fuel, explosions of fire-damp; and it also accumulates in pits, cellars, wells, and in old mines.

Symptoms.—If the gas is pure, death occurs immediately from apnœa, spasm of the glottis taking place. In a somewhat diluted state, muscular power is immediately lost, and death takes place without a struggle. When still more diluted, there are, irritation of the throat, pains in the head, giddiness, and drowsiness. Generally, the countenance and surface of the body are markedly livid. The heart's action is violent. These symptoms gradually disappear, and death results by complete coma. Carbonic acid is an absolute poison, and its action is not merely negative.

Post-mortem Appearances.—Those of death by apnœa. It is a specific narcotic poison as well as an asphyxiant. The brain and its membranes are extremely congested, serum being effused at the base and in the ventricles. Putrefaction is slow, and animal heat and rigidity are very persistent. The body is frequently much swollen, the eyes unusually brilliant, the blood dark and liquid, the abdominal viscera much congested.

Treatment.—This should consist in fresh, pure air, stimulants, artificial respiration, the cold douche, galvanism, inhalation of oxygen (say about two quarts), and moderate venæsection if the symptoms are distinctly apoplectic.

CARBONIC OXIDE.

This is a colourless gas, with a faint odour. which burns with a pale blue flame and is very poisonous.

Symptoms.—Giddiness, headache, nausea, vomiting and prostration, in fatal cases passing into insensibility and deep coma. It is a pure narcotic poison. It has been suggested that the cause of death with carbonic oxide is that the blood cannot become *venous*, whereas, with carbonic acid it cannot become *arterial*. The symptoms with carbonic oxide are singularly persistent, with carbonic acid they are transitory. It is also stated that the poisonous action of carbonic oxide is dependent upon the formation of a new and fixed compound of the substance with hæmaglobin.

Suicides, especially in France, not unfrequently destroy themselves by the charcoal vapour, and in this country fatal results have occurred accidentally from sleeping in rooms with a charcoal fire burning without a flue, or into which leakage from the stove-pipes has taken place.

Post-mortem Appearances.—In the spectroscope carbon c oxide blood shows two absorption bands, very similar to oxy-hæmaglobin; they differ somewhat in breadth, and are somewhat nearer the violet end. The blood is found persistenly *redder* than usual (a special characteristic); it is of a cherry-red tint, as are also the internal viscera, a darkened state of this fluid characterising cases of carbonic acid poisoning. The brain is somewhat congested. Carbonic oxide displaces oxygen in the blood, and produces a red chemical substance, forming a stable compound with the hæmaglobin.

Treatment.—Venæsection and transfusion of arterialised defibrinated blood.

SULPHURETTED HYDROGEN.

This gas has a characteristic odour—viz., that of rotten eggs.

Symptoms.—These vary with the dilution. When *very concentrated,* death is immediate. *Somewhat diluted,* there are giddiness, laboured breathing, gastric pain and death by coma. Still more diluted, mere sleeping results. When *extremely diluted,* symptoms of a typhoid nature set in, nausea being probably the first sign. The pupils are usually dilated.

Post-mortem Appearances.—These are fairly constant. The blood is dark, black and fluid, the viscera are distended, putrefaction is rapid, and the body exhales a putrid odour. The right side of the heart is usually gorged with blood. The characteristic appearance is that of the bronchial tubes, which appear as if *smeared with dirty-brown deposit,* and which can be wiped off with the finger. In death by carbonic-acid poisoning there would, of course, be no such indication.

Detection after Death.—If the body can be examined *immediately* (it is useless otherwise), a strip of bright silver or a piece of lead paper may be placed under the skin. These articles will be blackened. The locality where the accident occurred must be specially examined.

Treatment.—Fresh air and cold affusion. The patient should be made to inhale chlorine by breathing out of a vessel containing a small quantity of chloride of lime.

Test.—The odour and the precipitation of a brown or black deposit with acetate of lead.

SEWER GASES.

The sewer gas usually consists of a mixture of sulphuretted hydrogen, sulphide of ammonium, and nitrogen; but, according to Thénard, it is simply deoxidised air with excess of carbonic acid.

The symptoms are almost identical with those caused by sulphuretted hydrogen. The want of oxygen is rather the cause of the asphyxia than the quantity of carbonic acid, which may not exceed 4 per cent.

The fatal accidents in the Fleet Sewer in 1861 were undoubtedly owing to sulphuretted hydrogen, and were probably due to the action of an acid liquor upon the sulphides contained in the mud. The acid liquor, "sharps," which consisted of the washings of brass after it had been steeped in nitric acid, had been let into this sewer from a founder's and brass finisher's.

In all probability, if charcoal respirators were worn by the men when at work in the sewers, much danger would be avoided.

The emanations from dead bodies chiefly consist of ammonia, sulphuretted hydrogen, carbonic acid, and phosphuretted hydrogen; and these emanations have for centuries been regarded with special dread, but there are strong grounds for believing that the evils which have been stated to arise from dead bodies have been much exaggerated.

Putrefaction is, of course, delayed when bodies have been buried in lead, but at last the metal gives way by its becoming converted into carbonate of lead. Bodies have been removed with perfect safety from the London churches to the cemetery by enclosing them separately in a shell, the size of which allows of at least two inches between it and the coffin, this space being filled up with a mixture of equal parts of earth, carbonate of calcium, and charcoal.

CARBURETTED HYDROGEN. COAL GAS.

In coal gas are contained light carburetted hydrogen or marsh gas, olefiant gas, and other heavy hydrocarbons, ammonia, sulphuretted hydrogen, carbonic acid, carbonic oxide, free hydrogen and nitrogen.

These gases give out an extremely offensive odour, and burn with a yellowish-white flame.

Symptoms.—Headache, giddiness, and vomiting, followed by loss of memory, passing to unconsciousness, convulsions, and loss of muscular power, and at last complete asphyxia.

Treatment.—Fresh air, cold affusion, stimulants and artificial respiration.

Post-mortem Appearances.—The following appearances are given by M. Tourdes—viz., Coagulation of the blood, a deepened tinge of colour, brilliancy of coloration of the pulmonary tissue, abundant froth in the air-passages, engorgement of the vertebral nervous system, and extravasation of coagulated blood in the spinal column; injected state of the mucous membrane at the base of the tongue, and occasional rose-coloured patches on the thighs.

NITROUS OXIDE GAS. LAUGHING GAS.

Symptoms.—When mixed with air, a peculiar state of intoxication, which is often hilarious, results; undiluted with air, insensibility is occasioned, the face becoming livid and the pupils dilated. If inhalation be continued, dangerous indications of asphyxia and even death may follow. The anæsthesia resulting from this gas is thought to be due chiefly to its action as an asphyxiant, and not to any special narcotic power.

The **treatment** is that of asphyxia generally.

ASTHENICS.

OXALIC ACID.

This is an important acid, on account of its outward resemblance to Epsom salts, or sulphate of magnesium, for which it has often been taken by mistake, and, owing to its cheapness and well-known properties, has been frequently made use of to destroy life.

Symptoms of Poisoning.—If a large dose (half an ounce to an ounce) be taken, there is a hot, burning, acid taste, during the act of swallowing, tightness and pain in the throat, extending to the stomach, great pallor and clammy perspirations, feeble pulse, extreme prostration, with intense pain and tenderness over the abdomen, accompanied by vomiting. If the poison be diluted, the vomiting may not come on for a quarter of an hour or twenty minutes; in some cases this symptom has been incessant until death, whilst in others there has been little or no vomiting. It would appear that this acid exercises a remote effect upon the nervous system, since in cases of recovery from the poisonous symptoms, numbness and tingling of the legs have been observed, together with spasmodic twitchings of the muscles of the face, and loss of voice, continuing for a long time.

Treatment.—Magnesia, plaster from walls, and chalk (carbonate of calcium) may be given; this last-named substance is a direct antidote, since it forms, with oxalic acid, an inert substance—viz., oxalate of calcium. Vomiting may be afterwards encouraged by means of sulphate of zinc, in doses of twenty grains, and by tickling the fauces with a feather, or by the hypodermic injection of apomorphine. *The stomach-pump should never be employed.* Alkalies and their carbonates must never be given, since the resulting compounds are as poisonous as oxalic acid itself. Life has often been destroyed by the *Acid Oxalate of Potassium*, or *Salts of Sorrel*, which is sold as *Essential Salts of Lemon*; its poisonous properties depending entirely upon the *Oxalic Acid* it contains.

Post-mortem Appearances.—The mucous membrane of the mouth, tongue, and throat is white, as if bleached, and the stomach contains mucous liquid of a dark-brown colour, and almost gelatinous; perforation of the stomach is not very commonly observed, but the organ is often *black* and *gangrenous.*

Quantity Required to Destroy Life (*smallest recorded*).—One drachm.

Period at which Death has taken place (variable).—Death, in some cases, has occurred very rapidly, but in others it has been protracted to the fifth day.

Mode of Extraction from the Stomach.—If the liquid contents be very acid, they may be filtered at once; but if these are not very acid, they should be boiled with distilled water before filtration. If the contents be highly coloured, they should be boiled for some time with well-washed animal charcoal, being afterwards filtered and concentrated by evaporation. They may then be acidulated with acetic acid and acetate of lead added; oxalate of lead is thrown down; this may be diffused through water and into it sulphuretted hydrogen passed; the lead will be precipitated as the black sulphide, the oxalic acid being set free.

Tests.—(1) Nitrate of silver gives a white precipitate of oxalate of silver which is soluble in cold nitric acid, and when heated on thin platinum foil is entirely dissipated in white vapour, with slight detonation. (2) Sulphate of calcium gives a white precipitate of oxalate of calcium, soluble in the mineral, but not in the vegetable, acids.

HYDROCYANIC ACID. PRUSSIC ACID.

Symptoms of Poisoning.—These vary according to the amount of the poison taken, a large dose seeming to produce instantaneous death by its "*lightning action.*" If death is not immediate, there will be a hot, bitter taste in the mouth, with increasing giddiness and weakness, severe pain in the head, and gradual confusion of ideas, insensibility and loss of muscular power supervening; the eyes are bright, the face pale and bloated, the breathing becomes *stertorous*, and death may occur from suffocation; the odour of the poison will probably be observed in the breath; the hands may be violently clenched, the eyes glistening and fixed, with wide dilatation of the pupils. A shriek may just precede death, which occurs probably through shock.

Treatment.—This may be *general*, *e.g.*, cold affusion, artificial respiration, and the application of ammonia to the nostrils; or *chemical*, *e.g.*, a mixture of a proto and a per-sulphate of iron with a caustic alkali may be given internally, forming the inert *ferrocyanide of potassium*, and, should the mixture become acid, the inert *Prussian blue* will be formed. Of course, in addition to the above mode of treatment, vomiting may be excited by tickling the fauces with a feather, or by the exhibition of common salt mustard, and sulphate of zinc. If possible, the stomach-pump may also be used.

Post-mortem Appearances.—In some cases there have been no morbid appearances at all; frothy foam may be found about the mouth, and the *stomach* and *intestines* may be sometimes congested, although they are often quite natural. The *brain* usually presents turgescence of vessels with effusion of serum into the ventricles, the odour of the poison being easily recognised. The *lungs, liver, spleen and kidneys* are invariably gorged with blood. The *bile* has often been noticed to be of a deep-blue tint, the *arterial system* is empty, but the *venous system* is invariably gorged with dark-coloured blood. The *blood* may be black or of a cochineal-red colour; it is sometimes fluid and sometimes coagulated, and frequently exhales the odour of the poison. These appearances may be observed in whatever way the poison may be administered, whether introduced into the *rectum,* or *vagina,* or applied to *wounds* or to the *conjunctiva.*

Quantity Required to Destroy Life (*smallest recorded*).—Nine-tenths of a grain of the anhydrous acid (=45 minims of the officinal acid).

Period at which Death has taken place.—This may be instantaneous, but is modified by various circumstances.

Mode of Extraction from the Stomach.—Try to detect the odour. If the contents are alkaline, add diluted sulphuric acid, and place the mixture in a vessel standing in a basin containing warm water at 60° Fahr., and then apply to the rising vapour the following tests:—(1) Moisten a glass slide with nitrate of silver; a *white* cyanide of silver will be formed; this is (*a*) soluble in boiling nitric acid, and (*b*) when heated gives off cyanogen gas, which, when lighted, burns with a rose-coloured flame. (2) Moisten another slide with sulphide of ammonium; a *white* sulphocyanide of ammonium is formed, and on the addition of perchloride of iron to this a *blood-red* solution (sulphocyanide of iron) results, which is discharged by corrosive sublimate.

The general method adopted, however, is to distil the contents of the stomach at a *gentle heat,* and collect the rising vapour in a receiver, which is kept cool by being placed in cold water. If the amount be very small, caustic potash or nitrate of silver may be placed in the receiver, so as to fix the acid by the formation of the cyanide of potassium or the cyanide of silver.

Tests.—(1) The *silver* test; nitrate of silver (see above). (2) The *sulphur* test; sulphide of ammonium and perchloride of iron (see above). (3) The *iron* test; first add liquor potassæ to the acid, then a proto- and a per-salt of iron, and lastly a drop or two of strong sulphuric acid; *Prussian blue* is developed.

When dealing with the acid in the form of cyanide of potassium, it will not be necessary to add caustic potash to this last test.

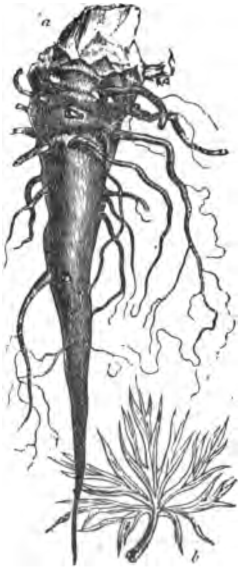
POISONING BY THE CYANIDES.—Death has resulted from both cyanide of potassium and cyanide of mercury; the symptoms of poisoning by the former being similar to those of poisoning by prussic acid, and in the latter, allied to those of poisoning by corrosive sublimate.

ACONITE. ACONITUM NAPELLUS.

The Monkshood, or Blue Rocket, contains an alkaloid, **aconitina**, which is probably the most powerful poison known.

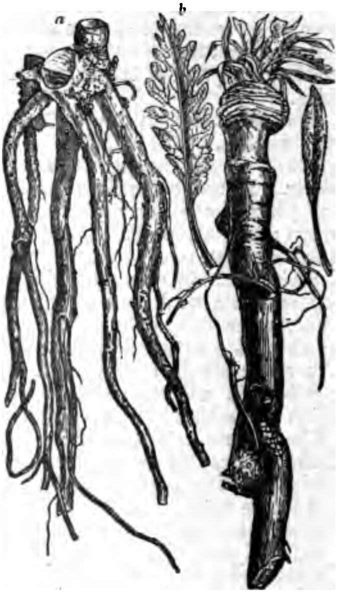
The aconite root has been eaten in mistake for that of the horse-radish. The characters and differences between these roots are shown in Figs. 117 and 118.

FIG. 117.



a. Aconite (*Aconitum Napellus*) showing the conical shape of the root and its throwing off a number of curling fibres. *b.* The leaf. The figure is the size of the root, but it may attain two or three times this size.

FIG. 118.



a. Horseradish (*Cochlearia Armoracia*) root. *b.* The leaf. The horseradish stick is cylindrical in all its branches, and throws off straight rootlets; it is externally buff-coloured, whereas the colour of the aconite root is dark nut-brown.

Symptoms of Poisoning.—There are numbness and tingling in the mouth and throat, soon becoming general; vomiting is a frequent symptom, purging not so common. Sensibility becomes diminished, there is ringing in the ears and deafness, with dimness and perhaps loss of sight; frothing at the mouth is not uncommon; the numbness of limbs, and tremblings, increase rapidly resulting at last in complete paralysis of both extremities; vertigo is not uncommon, but the mind is usually clear.

The power of speech disappears, and the breathing becomes slow and laborious, with intense prostration of strength. There is fearful dread of approaching death.

Cold clammy sweats, intense bloodlessness of the lips and countenance are common; the pupils as a rule are contracted, but they have been dilated.

Death may occur from one of three causes: by shock, asphyxia, or syncope.

Treatment.—An immediate emetic of sulphate of zinc. Finely powdered charcoal may be given, but the stomach-pump should be used immediately afterwards. Brandy and ammonia, and strong tea and coffee, should be given freely; advantage may be derived from liniments and from friction to the limbs and spine.

Mustard plasters may be applied to the pit of the stomach, and slight galvanic shocks to the heart.

Post-mortem Appearances.—General venous congestion; usually more or less engorgement of the brain and its membranes, the lungs and the liver. More or less blood, usually fluid and dark, is contained in the right cavities of the heart. Finally, there are in general indications of gastro-intestinal irritation.

Quantity Required to Destroy Life.—60 grains of the root, [illegible] grains of the alcoholic extract, and one ounce of the tincture have caused death. Bad symptoms have arisen from the mere inhalation of the aconite dust, whilst powdering the root.

Period at which Death takes place.—Symptoms may appear in a few minutes, to one or two hours. Death generally occurs within 3 or 4 hours; one case has been delayed for 20 hours, and another took place in 20 minutes.

Mode of Extraction from the Stomach.—Search should be made carefully for parts of the plant, for the purpose of identification.

The contents of the stomach and intestines should be placed in a clean, wide-mouthed bottle, and, when made acid by a few drops of acetic or hydrochloric acid, heated with a considerable amount of alcohol, and set aside for some hours in a warm place. The materials should then be filtered through thick blotting paper, and the filtrate treated with excess of subacetate of lead, and the precipitate again filtered; through the clear filtrate sulphuretted hydrogen should be passed, in order to get rid of the lead as sulphide. The clear filtrate should be evaporated to dryness, and the residue dissolved in a few drops of water, acidulated with acetic acid. This alcoholic extract should be supersaturated with bicarbonate of potassium, and the alkaloid (aconitina) extracted either by ether or chloroform.

The extract should be tested as to its power of producing numbness and tingling, by rubbing a small portion with the finger on the gums and lips. If this proceeding fails, it is doubtful whether any further attempts will be of any use. The presence or absence of aconite must be judged more by the physiological action and symptoms than by chemical tests.

Tests for Aconitina.—1. The physiological action:—(*a*) Rubbed inside the gums, the sense of tingling and numbness. (*b*) Given to small animals, causing staggering, weakness, laborious breathing and convulsive twitchings, and diminution of common sensation (small pins being stuck into a dog under the influence of the poison causing no pain). (*c*) Iodine or iodide of potassium gives, both with the alkaloid and its salts, a reddish-brown amorphous precipitate.

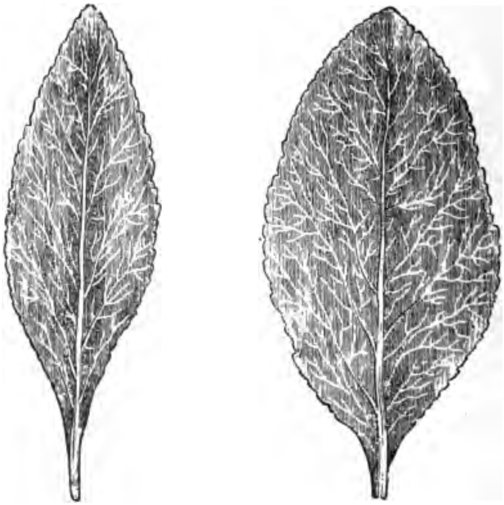
DIGITALIS. DIGITALIS PURPUREA. THE PURPLE FOXGLOVE.

All parts of this plant are poisonous, from the presence of an alkaloid, **digitalinum**. The leaves are shown in Fig. 119.

Symptoms.—Nausea, purging, vomiting, and pain in the abdomen, with giddiness, headache, and dimness or loss of sight. The pupils are dilated and insensible. The pulse is irregular, slow, and weak. Stupor and syncope succeed.

Post-mortem Appearances.—Congestion of the brain and its membranes, and inflammation of the mucous membrane of the stomach.

Fig. 119.



Digitalis purpurea. The leaves

Treatment.—Stimulants, aperients and emetics, and infusions containing tannin—viz., tea, coffee, oak-bark, galls.

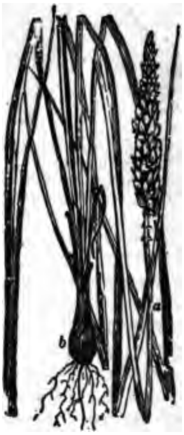
Tests for Digitalinum. This is a white substance only slightly soluble in water; with hydrochloric acid it turns yellow, passing to green. When evaporated to dryness and treated with sulphuric acid, a rose colour is developed, which turns to a mauve with bromine vapour. Its action on the frog's heart is characteristic, causing irregularity in the beats, stoppage of the ventricle in the white, contracted state, with retention of the voluntary power when the heart stops, and for quite 15 to 20 minutes afterwards.

For extracting Digitalis from the stomach, recourse must be had to Stas's process.

VERATRINA. SCHŒNOCAULON OFFICINALE. SABADILLA.

The poisonous action of the Sabadilla (Fig. 120) is due to the action of its contained alkaloid **veratrina**, of which $\frac{1}{16}$ grain has produced in the human subject dangerous symptoms, accompanied by collapse.

FIG. 120.



Schænocaulon Officinale.
a. The fruit-bearing stem.
b. The root, bulb, and leaves.

Treatment.—Emetics, the stomach-pump and powdered charcoal, tannin infusions and stimulants must be used; opium combined with purgatives may subsequently be employed.

Tests.—1. Veratrina possesses no smell, but, when applied to the nostrils, induces violent and uncontrollable sneezing.

2. Sulphuric acid first turns the alkaloid yellow, then a rich crimson. When the acid is gently heated the red colour appears instantaneously.

3. Nitric acid changes it to a light red, becoming yellow.

COLCHICUM AUTUMNALE. THE MEADOW SAFFRON.

This plant with its leaves and fruit is shown in Fig. 121.

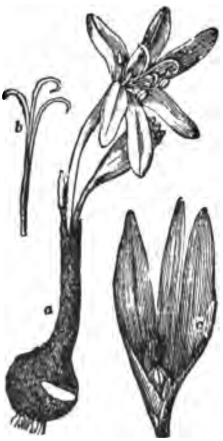
Symptoms.—These may commence at once, and are rarely delayed beyond three hours. There are pain, purging and vomiting of matters often mixed with blood; cramps, sometimes convulsions, thirst, intense irritation of the throat, great coldness and prostration, and dilated pupils. Not unusually the symptoms resemble very closely those of malignant cholera. Suppression of urine and delirium have been observed. Death has resulted in seven hours, but has been delayed for eight days; in most cases it takes place within twenty-four hours.

Recovery is on record after 1 ounce of the wine of colchicum and 1 ounce of the tincture respectively; and death has followed the taking of 1 ounce of the wine, a tablespoonful of the seeds, 48 grains of the dried bulb, and a handful of the flowers.

Post-mortem Appearances. — The stomach and intestines are almost always inflamed. Purple patches are often seen on the skin, and sometimes on the internal organs; the bladder is usually empty, the heart full of coagulated blood, and the liver, spleen, brain and spinal cord are generally congested.

The alkaloid **colchicina** is said to be identical with Veratrina, but this is doubtful. It does not produce the violent sneezing which is characteristic of Veratrina. It yields with nitric acid a reddish violet colour, soon passing off.

FIG. 121.



Colchicum Autumnale. *a.* The flowering plant. *b.* Stigmas, with a portion of the styles. *c.* Leaves and fruit.

INEBRIANTS.

ALCOHOL.

Alcohol, like ether and chloroform, induces narcotism; delirium with excitement is often an early symptom, and it is succeeded by nausea and vomiting. Death may result, the heart becoming paralysed, or a condition may be established resembling apoplexy.

When pure, alcohol is a colourless volatile liquid which cannot be frozen, and which is very inflammable.

Symptoms of Acute Poisoning.—These are giddiness, confusion and headache, leading to deep stupor and coma. Vomiting may set in and recovery follow, or death may result. The pupils are usually, but not invariably, dilated.

Post-mortem Appearances.—The lining membrane of the stomach is of a deep-red colour, and the cerebral vessels and membranes are sometimes congested. The lungs are congested and the blood is fluid. Rigor mortis is persistent.

Treatment.—The stomach-pump may be employed in addition to cold affusion, ammonia, and galvanism.

Tests.—Its odour. Upon the addition of diluted sulphuric acid and bichromate of potassium, alcohol turns green, and evolves aldehyde.

Method of Extraction from the Stomach, &c.—If acid, the contents of the stomach should be neutralised with carbonate of sodium. They should then be placed in a retort, and carefully distilled. The distillate should be collected and mixed with chloride of calcium or anhydrous sulphate of copper, and again distilled. The distillate is finally shaken with dry carbonate of potassium, some of the supernatant fluid being drawn off for testing purposes.

A person may be found in an unconscious state. This unconsciousness may be caused by drunkenness, narcotic poisoning, epilepsy, uræmia, or by concussion from a blow or a fall. The history is of great importance.

In *Narcotic Poisoning*, the pupils are usually contracted. There is no hemiplegia, no remission in the insensibility, but there is increasing coma.

In *Drunkenness*, it is possible to arouse the patient to some extent, since the insensibility is not complete. There is no hemiplegia, and the smell of alcohol may be detected in the breath. It must not, however, be forgotten that an apoplectic attack and drunkenness may coexist, and that therefore a very careful opinion must be given.

If resulting from *Epilepsy*, the duration of the attack will not be long, and there will be a history of previous attacks.

In *Uræmia*, hemiplegia is absent. Upon drawing off the urine, this fluid will be found to be albuminous, and probably dropsy will be found in various parts of the body.

With *Concussion*, there may be bruises or injuries on other parts of the body, possibly bleeding from the nose or ears, and other indications of the insensibility arising from accident.

Drinking to excess sometimes occasions a form of delirium known as *Delirium Ebriosum*, which differs pathologically from delirium tremens, but may be sometimes mistaken for it. Here the delirium is active, sometimes violent, and sometimes hilarious; it is in reality a form of acute mania induced by cerebral congestion associated with the immediate effects of alcohol upon the brain, and may be considered a variety of cerebritis, or inflammation of the brain. This condition is caused, not by habitual alcoholic indulgence, but rather by a single protracted paroxysm of drinking. It lasts only for a short time, but may in some cases be followed by delirium tremens.

Alcoholismus, Alcoholism, or prolonged, excessive, and habitual indulgence in alcohol, viz. chronic poisoning by alcohol, enters largely into the causation of numerous affections, as cirrhosis of the liver, fatty liver, epilepsy, gastritis, pyrosis, and other forms of dyspepsia, and diseases of the kidneys (Bright's disease); it indirectly favours the production of nearly every disease by diminishing the resisting power of the system, and it also increases the fatality by lessening the capability of overcoming the tendency to death. The immoderate use of alcohol acts deleteriously upon the whole economy. In chronic alcoholism the powers of digestion are impaired, the appetite is partially destroyed, the muscular system weakened, and the generative function decays. The skin and muscles become flabby. Pain in the back and limbs frequently occurs. The breath and the emanations from the skin have a characteristic odour. The perceptions are blunted, deterioration of the moral and intellectual faculties takes place, until at last the inebriate has but one desire in life—viz., to satisfy the morbid craving for alcohol. This condition constitutes the disease known by the name of **Dipsomania.**

ETHER.

This substance, when pure, is a limpid, colourless liquid.

Symptoms.—When taken in a liquid form, ether produces the same symptoms as alcohol. When it is inhaled in vapour, prolonged, slow and stertorous breathing results; the surface of the body becomes cold, the lips blue, and the face pale; the pulse is at first accelerated, but afterwards slows; the muscles become relaxed and flabby; the pupils are dilated, the eyes becoming fixed and glassy; anæsthesia is deep and well marked; coma succeeds, with complete abolition of sensation; nausea and vomiting are not unfrequently present.

Post-mortem Appearances.—There is congestion of the brain and lungs and of the vessels at the upper part of the spine. The heart's cavities are filled with liquid dark blood.

Treatment.—In poisoning by the liquid, the stomach-pump should be employed, emetics being used afterwards. Exposure to pure air, cold affusion, artificial respiration, and galvanism are indicated when inhalation has proved dangerous.

Method of Extraction from the Stomach.—This is the same as with alcohol poisoning. During the distillation, some of the vapour should be passed into a concentrated solution of bichromate of potassium, sulphuric and nitric acids, and the reaction observed as for alcohol.

Tests.—The vapour of ether burns with a smoky flame, carbon being deposited. With bichromate of potassium and diluted sulphuric acid, ether turns green, evolving aldehyde.

CHLOROFORM.

This is a very volatile, colourless liquid with a sweet taste and pleasant odour. It gives off a dense vapour.

Symptoms.—Locally an irritant. When swallowed, it causes symptoms of irritant poisoning, rapidly succeeded by coma. When inhaled, produces symptoms similar to those following the administration of ether, but muscular relaxation and insensibility appear much sooner. Death appears to result from paralysis of the respiration or circulation; it is probable that chloroform acts directly upon the nerve centres.

Post-mortem Appearances.—In many cases, the appearances of death by asphyxia. On opening the body, the odour of chloroform is often perceptible. The heart is often collapsed and flabby.

Treatment.—Cold affusion and the treatment proper to asphyxia. Bleeding from the jugular vein may be beneficial.

Mode of Extraction from the Stomach.—The suspected substances are distilled at 120° Fahr. in a receiver, through the neck of which passed a tube bent at right angles. The horizontal portion of the tube outside the receiver passes over a flame: as the vapour of the chloroform ($CHCl_3$) passes along this horizontal tube, it is decomposed by the heat into chlorine, hydrochloric acid and carbon. The chlorine may be known by applying to it some starch-paper dipped in iodide of potassium, the iodine being set free and forming the blue iodide of starch; the hydrochloric acid, by its reddening blue litmus paper; and the carbon, by its black deposition.

Tests.—The odour and taste. It burns with a green flame, and dissolves caoutchouc, gutta-percha and camphor.

CHLORAL HYDRATE.

This substance is obtained by passing dry chlorine through absolute alcohol. It has a characteristic odour and taste.

Symptoms.—A pure hypnotic in medicinal doses, producing deep sleep, which is succeeded by loss of consciousness. The face may become flushed, and the pulse quick. A peculiar eruption has been stated to be produced by the prolonged use of this drug. In poisonous doses, profound sleep results, passing into coma, from cessation of the circulation and respiration. The pupils are at first contracted, and then dilated. The action of chloral hydrate is supposed to be due to its decomposition in the blood into an alkaline formiate and chloroform.

Mode of Extraction from the Stomach.—The suspected matters are first treated with potash, to form a formiate of potassium and chloroform, the latter being tested for as previously described.

CARBOLIC ACID. HYDRATE OF PHENYL.

Symptoms of Poisoning.—Immediate vertigo and intoxication, accompanied by intense burning pain, extending from the mouth to the stomach, and by occasional vomiting of frothy mucus; the *pupils are invariably contracted,* the pulse is rapid and intermittent, the breathing stertorous, and the breath smelling strongly of the poison. Any urine passed is *dark-coloured* and *smoky,* but there is frequently complete suppression of urine; *intense coma* may supervene with convulsions. Death may occur rapidly from syncope, or may be prolonged, when it will be probably due to apnœa. The chance of recovery is very slight. Death occurs usually in from thirty minutes to four hours, the shortest recorded period being ten minutes, and the longest sixty hours. Six or seven drops of this acid may cause dangerous symptoms, but the recorded deaths have been generally caused by one or two ounces, which, of course, is a much greater quantity than is necessary to prove fatal. When used as an injection, or externally applied, fatal results have followed.

Treatment.—The stomach-pump may be employed, and oil and demulcent drinks administered. Sulphate of sodium (Glauber salts) has been proposed as an antidote. Emetics are of little use, in consequence of the marked anæsthesia of the gastric mucous membrane, but injection of stimulants may be tried, to counteract collapse.

Post-mortem Appearances.—The œsophagus and mouth are white and corroded, the brain is sometimes congested, fluid being found in the ventricles, which smells strongly of the acid. The stomach is generally white, thickened and contracted, but sometimes it is intensely congested, and the mucous membrane destroyed.

Mode of Extraction from the Stomach.—Unless the odour of the carbolic acid can be detected, no tests are likely to be of any avail. For the recovery of the acid, all that is necessary is to mix the organic matters with diluted sulphuric acid, and distil.

Tests.—1. The *odour* is the most delicate test. 2. It precipitates collodion and albumen. 3. By mixing the acid with one-fourth of its volume of liquor ammoniæ, and adding a trace of a solution of a hypochlorite, and gently warming the mixture, the liquid assumes a *blue* colour, and, if this be acidulated, it turns *red.* 4. Neutral perchloride of iron, when added to the acid, developes a *violet colour,* the intensity of which entirely depends upon the strength of the reagents employed. 5. Solution of ammonia and of chlorinated soda give a *deep purple coloration.*

NITRO-BENZOLE, or ESSENCE OF MIRBANE.

This is a heavy liquid of a yellow colour with an odour of oil of bitter almonds; it is prepared by the action of nitric acid on benzole.

Symptoms.—Headache, stupor, and intoxication, with dilated pupils, followed by convulsions and death.

ANILIN.—The symptoms are essentially those of nitro-benzole, but they perhaps commence earlier. In acute cases, death usually occurs from coma. The anilin dyes are obtained by treating anilin with oxidising agents, especially with arsenic; and when anilin-dyed fabrics have been worn next the skin, painful and obstinate eczematous eruptions have occurred, from the presence of this metalloid.

BENZOLE or **BENZINE.**—This limpid, colourless fluid gives off a highly-inflammable vapour, both the liquid and the vapour having poisonous properties.

OIL OF TURPENTINE.—The properties of this liquid are partly narcotic and partly irritant. In some instances it has produced violent irritation of the urinary organs, and in others intoxication, succeeded by collapse, coma and convulsions.

KREASOTE.—This substance in a large medicinal dose has produced gastric and intestinal irritation with headache, giddiness, and drowsiness.

FUSEL OIL (potato spirit, amylic alcohol) acts as an inebriant, causing headache, giddiness and staggering.

Oil of Dippel.**—A product of the destructive distillation of bones**

(hartshorn); it causes vomiting, and gastric and intestinal irritation, with strong corrosive action on the gullet and mouth.

Coal Naphtha has caused intoxication, furious delirium, and stertorous breathing.

NITRO-GLYCERINE is a powerful poison, both as a liquid and in vapour. Small doses produce intense headache and violent beating in the temples. In fatal cases, death has resulted from coma without convulsions, after cyanosis and intense dyspnœa.

PURGATIVES.

Symptoms.—The following drugs produce vomiting and purging, pain in the abdomen, cramps, strangury, and tenesmus, followed by collapse, and sometimes accompanied by drowsiness and slight nervous symptoms.

Post-mortem Appearances.—Inflammation of the alimentary canal, redness, ulceration, softening, and effusion of dark blood into the submucous tissue.

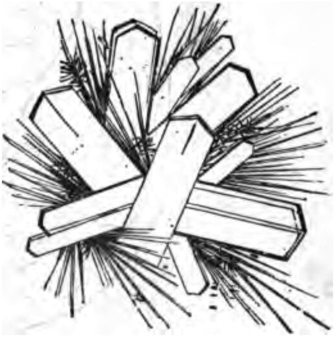
Treatment.—Diluents, stimulants to counteract collapse, and opium for the relief of pain.

ALOES.—The inspissated juice of the leaf of the Barbadoes and Socotrine aloes forms a leading ingredient in quack pills, and, mixed with powdered canella, constitutes the well-known hiera picra, or holy bitter. Both the quack pills and this powder have proved fatal in large quantities. The active principle of aloes is **aloin,** which gives a yellow colour with cold sulphuric acid, changing to green when heated,

FIG. 122.

Aloe Socotrina or Aloe Perryi; the plant.

FIG. 123.



Aloïn, prepared from Barbadoes Aloes (Aloe Vulgaris). Microscopical appearance.

In acute and chronic poisoning of animals by aloïn, albuminuria has been observed.

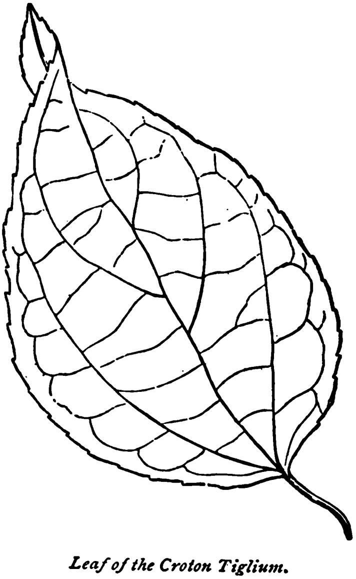
Fig. 122 shows the Aloe Socotrina or Aloe Perryi (the plant), and in Fig. 123 is seen the active principle Aloïn, prepared from Aloe Barbadensis, the Aloe Vulgaris.

JALAP (Ipomœa Purga).—This is a drastic purgative yielding an active principle, **convolvulin**, giving with cold sulphuric acid a yellow tint, changing to red-brown when heated.

CASTOR-OIL SEEDS (Ricinus Communis).—These seeds act upon the stomach and intestines with a violence out of all proportion to the action of the oil which they would yield by compression. Three seeds proved fatal to an adult in forty-six hours. The seeds themselves present a beautifully-marbled appearance.

CROTON OIL (Croton Tiglium).—The oil of the seeds had proved fatal, with symptoms of acute irritant poisoning and collapse, resembling most severe cases of cholera. The seeds present a dull, dirty appearance. The leaf of the plant is shown in Fig. 124.

FIG. 124.



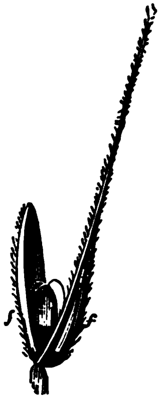
Leaf of the Croton Tiglium.

ELATERIUM.—This is a drastic hydragogue purgative. It is on record that a medical man in Paris, merely through carrying a specimen of the plant in his hat for twelve hours, became affected!

with severe pain and tightness in the head, purging, colicky pains, fever and bilious vomiting.

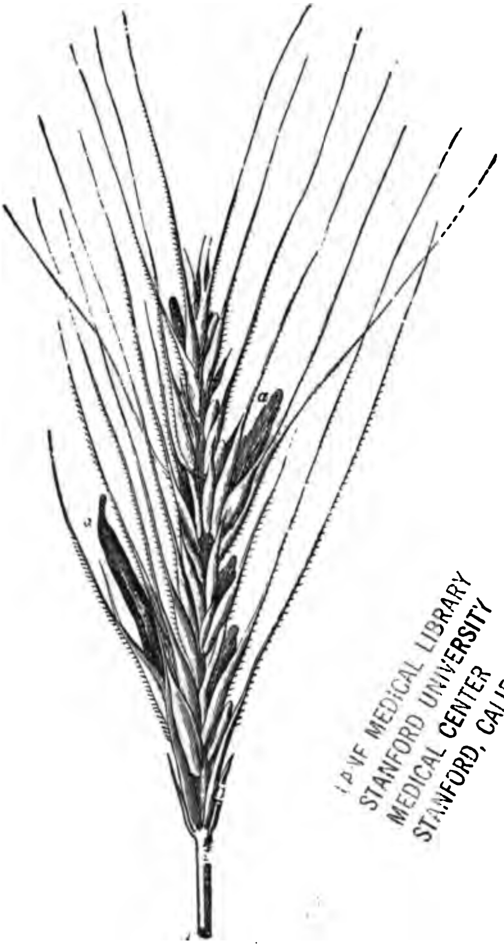
HELLEBORES.—The true Hellebore (Helleborus Orientalis), the Black Hellebore, " the Christmas rose " (Helleborus Niger), and

FIG. 125.



Secale Cereale, the common rye. *f f.* The paleæ.

FIG. 126.



Secale Cornutum, the spurred rye. The full-grown ear of rye, strongly infected with ergot (natural size). *a a.* Mature ergot.

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the Stinking Hellebore (Helleborus Fœtidus), all produce violent symptoms of gastric and intestinal irritation.

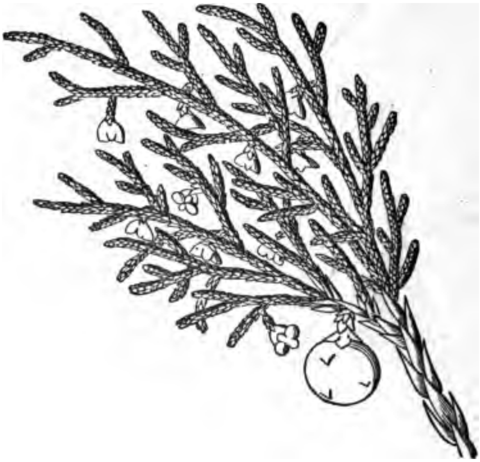
ABORTIVES.

ERGOT OF RYE. SECALE CORNUTUM.

This is the product of a fungus (the Claviceps purpurea) attacking and replacing the grain of the rye (Secale Cereale, Fig. 125). The diseased grains occupy the ear of the plant; each grain is deep purple, and somewhat resembles the spur of a cock (Fig. 126).

Symptoms.—Cases of poisoning by ergot of rye have chiefly taken place from eating bread made of ergotised grain. The bread soon becomes moist, and wanting in firmness.

FIG. 127.



Juniperus Sabina in fruit.

The activity of ergot used to be ascribed to two principles, *ergotin* and *ecbolin*, but the latest researches have indicated the following:—*Ergotinic acid*, *sphacelinic acid*, and an alkaloid *cornutine*.

Two different poisonous conditions are produced by ergot, and they may be present, either singly or combined:—

(*a*) *Convulsive or Nervous Ergotism.*—In which the prominent symptoms are giddiness, cramps, and convulsions.

(*b*) *Gangrenous Ergotism.*—Beginning with a peculiar creeping sensation, the limbs becoming insensible, and finally shrivelling up and dropping off at the joints.

The general symptoms of a poisonous dose are nausea, vomiting, and stupor, both the frequency and force of the pulse being diminished. The amount of urine is increased under its influence

Tests.—Ergot gives with liquor potassæ a lake-red tint, and develops an odour of herring's brine, due to trimethylamine.

SAVIN. JUNIPERUS SABINA.

This plant yields a round purple fruit in size about that of a currant. It is shown in Fig. 127.

Symptoms.—These do not come on immediately; there are usually vomiting, pain, and violent tenesmus, succeeded by coma.

If the patient is pregnant, abortion may or may not occur.

Death has resulted in fifteen or sixteen hours after swallowing the poison, and, on the other hand, it has been delayed for several days.

Post-mortem Appearances.—Usually congestion of the capillary and venous systems, the blood being black, and the heart full, especially on the right side. There is a specific action on the vessels of the lower bowel, inflammation and turgidity being induced. The true action of savin with regard to its supposed abortive power is due to its action on the lower bowel, the uterus participating in the general plethora of the intestinal system. Savin, however, very frequently fails to produce abortion, even when it produces violent symptoms of poisoning.

Mode of Extraction from the Stomach.—The contents of the stomach, if powdered savin has been taken, will probably appear of a green colour, and the microscope will show the coniferous structure of the herb. The organic matter should be distilled, when a *turbid* liquid will come over, tasting and smelling like oil of savin. To this liquid ether should be added, when it will instantly clear, and on evaporation the oil will remain behind.

By rubbing the herb in a mortar the odour may be developed. The watery solution strikes deep green with perchloride of iron.

IRRITANTS WITH NERVOUS SYMPTOMS.

ŒNANTHE CROCATA (the Hemlock, Water Dropwort) somewhat resembles celery; its root is rather like the parsnip. A very small piece has proved rapidly fatal, with symptoms of violent intestinal irritation, tetanic spasms and acute pain. Like the three following, this plant belongs to the order Umbelliferæ.

CICUTA VIROSA (the Water Hemlock or Cowbane).—The root-stalk of this plant has been mistaken for parsnip. It produces tetanic spasms, dilatation of the pupils, insensibility, vomiting, diarrhœa and coma. Corrosion and perforation of the stomach have been observed on post-mortem examination.

PHELLANDRIUM AQUATICUM (the Fine-leaved Water Hemlock) has also been mistaken for parsnip.

ÆTHUSA CYNAPIUM (**the Fool's Parsley** has been mistaken for parsley, and its roots for young turnips. It has been stated to produce heat in the mouth, vomiting and nausea with headache, trismus (lockjaw), stupor and dilatation of the pupils.

TAXUS BACCATA (the Yew).—The leaves and berries produce symptoms of irritant poisoning, accompanied by insensibility and convulsions.

CYTISUS LABURNUM.—This plant contains an alkaloid, **Cytisine**, and produces irritation of the alimentary canal, convulsions, dilatation of the pupils and rigidity of the limbs.

SIMPLE IRRITANTS.

ARUM MACULATUM (Lords and Ladies, Cuckoo Pint).—All parts of this plant are irritating and acrid.

DAPHNE MEZEREUM.—Mezereon yields bright-red berries, which have been taken by children in mistake for currants.

RANUNCULUS (Crowfoot, Buttercup).—There are fifteen species of ranunculus, most of them having more or less irritating properties. Those considered the most poisonous are Ranunculus flammula, bulbosus, and sceleratus; the Ranunculus arvensis and acris are less injurious. The juice of the plants acts as a powerful vesicant.

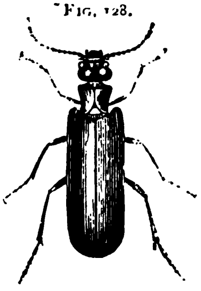
BRYONIA DIOICA (the Wild Vine or White Bryony) and TAMUS COMMUNIS (the Black Bryony).—Both possess irritant properties.

The symptoms, treatment, and post-mortem appearances of all the above are those of irritant poisons in general.

ANIMAL IRRITANTS

CANTHARIS VESICATORIA.

Fig. 128.



Cantharis Vesicatoria. The Spanish Fly or Blister Beetle.

This insect is commonly known as **the Spanish Fly** (Fig. 128). The flies (Cantharides) collectively have been given, in the form of powder and tincture, to excite the sexual passion, to procure abortion, or merely for a joke.

The cantharis contains an active and irritant poison, termed **cantharidine,** which crystallises in colourless plates, and is possessed of strong blistering properties. It also sublimes without residue, and with it sulphuric or nitric acid produces no change of colour. The one-hundredth of a grain of cantharidine will raise a blister on the lips.

Symptoms.—These are: a burning sensation in the mouth, throat, and pit of the stomach, great pain in swallowing, thirst, bloody stools, and *vomiting of bloody* mucus, mixed with shining green particles (when the substance has been taken in the form of powder), priapism with inflammation and swelling of the genitals and distressing strangury; occasionally tetanic spasms, convulsions, and delirium.

Fatal Dose.—One ounce of the tincture of cantharides.

Fatal Period.—Twenty-four to thirty-six hours.

Treatment.—Emetics and thick warm liquids. Opiate injections into the rectum and bladder, and opium suppositories. Leeches should be applied if much inflammatory action is present.

Post-mortem Appearances.—The mouth and gullet are usually found denuded of mucous membrane, and the alimentary canal, genitals and urinary tract are commonly the seat of intense inflammation. Portions of the wings and the wing-cases of the insects may be found in the stomach, and detected by the microscope.

Detection after Death.—Particles of the insect should be looked for; it is said they are more likely to be found in the large intestines. They have a great power of resisting putrefaction, and may be found months after death. The particles should be acted upon by chloroform or ether, the solvents poured off and evaporated down, and the extract applied to the ear of a rabbit to note whether a blister is produced.

POISONOUS FOODS.

Meat may become poisonous under certain circumstances. In some cases, as with pork, no cause for the poisonous action can be assigned, and it is then probably due to idiosyncrasy, although at times definite changes in the meat can be traced.

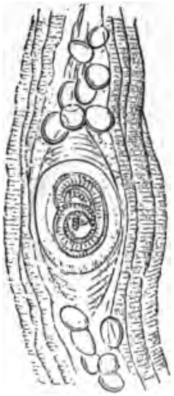
Putrid meat induces symptoms of an irritant poison, vomiting and purging being both the symptoms and the cure. Gangrene and scurvy have resulted from the ingestion of putrid meat, and bad symptoms have resulted from partaking of musty bacon, decaying mutton, and mouldy veal. The Wurtemberg-sausage poison is an instance of the evil effects produced by modified putrefaction, since these ill-effects do not result if the sausages are allowed to undergo complete putrefaction. It is stated that the poisonous action is due to a minute fungus, the *Sarcina botulina*, and it is supposed that this active body is developed by partial decomposition, and destroyed when the decomposition is perfect. The symptoms seldom appear in less than twenty-four hours, and frequently after a much longer period, terminating with convulsions between the third and eighth day, or by a very prolonged convalescence if the case ends favourably.

TRICHINA SPIRALIS—TRICHINIASIS—TRICHINOSIS.

The trichinæ are exceedingly minute worms, and are found in the muscular tissue, each being coiled up within an oval cyst, and appearing to the naked eye as tiny white grains. The colour of the affected muscles is pale reddish-grey, speckled with small light points of trichinæ, which exist in all stages of development, lying upon and within the sheaths of the muscular fibres. They have been found in all the voluntary muscles, and have been seen in the heart's substance.

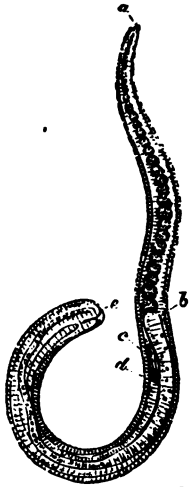
Microscopically the Trichina spiralis appears of a spiral form, coiled up within the sarcolemma of the muscular fibres (Figs. 129 130).

FIG. 129.



Trichina Spiralis, coiled up within its Cyst, with groups of fatty cells at either end. × 50.

FIG. 130.



Trichina Spiralis, removed from its cyst. *a*, The mouth; *b*, commencement of the alimentary canal; *c* and *d*, tubular sac with granular body, extending to *e*, the anal extremity.

Symptoms.—Great depression and lassitude, loss of appetite, and sleeplessness. There is fever, with severe muscular pains, and occasionally swelling of the joints, with œdema of the face and eyelids, succeeded at times by persistent painful contractions of the flexor muscles of the extremities. Frequently the disease commences with diarrhœa, sometimes typhous symptoms supervene, the patient dying unconscious; but the malady usually ends in pneumonia. When fatal, trichinosis runs its course within a month from the reception of the parasite.

Source of the Parasite.—Very rare in this country, but common in Germany, from eating imperfectly cooked or raw pork or sausages. As soon as the ova are introduced into the stomach the trichinæ commence to develop, numberless embryos being produced in the intestines, from which they advance to the muscles, setting up violent symptoms until they become enveloped in capsules, in which condition they are harmless.

Treatment.—This must consist in avoiding German sausages or raw or under-done pork, since no remedy is known which is capable of killing the trichinæ. Santonine, being a substance which is rapidly admitted into the blood, may be tried.

POISONOUS FISH.

Some fish, as the conger-eel, the mussel, and the oyster, which are ordinarily nutritive, are at times found to be poisonous; some are poisonous to one person and harmless to another. Of mussels, as few as ten, six, or even one, have caused dangerous symptoms. It is probable that the poisonous action is due to some definite animal poison, of which the nature is unknown, in the fish itself. The symptoms may appear in as soon as 10 or 15 minutes, or be delayed for 24 hours. They are occasionally simply instances of local irritation—sometimes a nettle-like eruption, with severe irritation, ushered in by coryza and itching of the eyelids and eyes, succeeded, and sometimes preceded, by troublesome asthmatical indications. At times a condition is observed which consists of extreme muscular debility, inability to stand, feeble action of the heart, numbness of the limbs, epileptiform convulsions and coma. As a rule, patients recover; but death has resulted in 3 and 7 hours. From time to time dangerous symptoms have arisen from partaking of eels, crabs, oysters, lobsters, and mackerel.

The **Treatment** consists in the elimination of the poison by emetics and purgatives, and in supporting the patient. Ether appears to be useful.

CADAVERIC ALKALOIDS—PTOMAINES—LEUCOMAINES.

These substances are formed during the process of putrefaction, and they occasionally result from the decomposition of albuminoid bodies independently of putrefaction. They have been found in poisonous sausages, decayed fish, ice cream, cheese, and the sea-mussel, which have all proved toxic to man. Ptomaines, found in decomposing viscera, have various kinds of action. One ptomaine, separated from putrefied brain, produced paralysis of the ends of motor nerves in a similar manner to curare; another from poisonous sausages, and from a post-mortem maceration fluid, acted like atropine. From persons who have died from acute arsenical poisoning, poisonous bases have been extracted, these being compounds of ptomaines with arsenic—*i.e.*, arsines; one was volatile, and another acted like strychnina. Being found in the body after death, ptomaines may occasion serious doubt in a case of suspected poisoning by a vegetable alkaloid. To distinguish ptomaines from vegetable alkaloids two separate liquids are taken, one in which a ptomaine is contained, and another having a vegetable alkaloid; in each a precipitate is occasioned by iodomercurate of potassium, but the one in which the ptomaine is present gives, with ferridcyanide of potassium and perchloride of iron, a precipitate of prussian blue, the ferridcyanide being reduced to the ferrocyanide. In the liquid having the vegetable alkaloid this reduction does not occur.

The alkaloids veratrine and morphine are exceptions to this rule.

VENOMOUS REPTILES.

In England there is only one venomous snake—viz., the **common viper** or **adder**, the **Vipera verus**. Two varieties of this reptile have been found—viz., the brown and the blue-black.

Symptoms.—Sharp pain in the bitten part, with swelling, redness passing to lividity, blisters forming round the wound like a burn, and gradually extending. There are anxiety, cold sweats, and faintness, bilious vomiting, and diarrhœa; the pulse is small and irregular, and the breathing difficult; there are sometimes convulsions and mental disturbance.

Treatment.—A ligature should be applied immediately between the wound and the heart, and the poison removed by suction. Ammonia should be applied to the wound, and also administered internally. Tincture of iodine is a good application to the stings of venomous insects.

PART III.

HYGIENE.

AIR.

THE atmosphere is the gaseous envelope of the earth, and forms the ocean of air at the bottom of which we live. Its average composition may be said to be the following:—

100 volumes of air contain—

Oxygen	20·6 volumes
Nitrogen	77·9 „
Carbonic anhydride	0·04 „
Aqueous vapour (about)	1·46 „
Ammonia	traces
Ozone	
Nitric acid	
Marsh gas	
Sulphurous anhydride	
Sulphuretted hydrogen (in towns)	
Substances derived from various industries in different localities	
	100·00

As most of the last-named ingredients are present in small and variable proportion, they are generally separated first in an analysis of air.

By oxygen, animal life is supported; the nitrogen serves to dilute the oxygen; carbonic anhydride and ammonia nourish plants; water favours the absorption of these, and ozone purifies the air.

Of *Carbonic Acid*, there are present from 4 to 6 volumes in 100·00 of air. The proportion of ozone is various, but is greater in the country than in town. To detect the carbonic acid, we expose a vessel containing lime-water to the open air. The lime-water soon becomes turbid, from the formation of insoluble carbonate of calcium.

The amount of aqueous vapour is dependent for the most part upon temperature, and varies with latitude, season, and region, &c.

The quantity of ammonia in the form of carbonate and nitrate is small, being about 1 part in 1,000,000 of air; its presence can only be shown by acting upon large quantities of air.

It is difficult to say where the air exactly ceases, but it seems that the limit is about 45 miles from the level of the sea, although from the observation of meteorites it has been assumed to be 200 miles. Of course, the atmosphere having weight and elasticity, its lower layers must be more compressed than those above them. If the whole atmosphere were of the same density throughout, it would reach only to a height a little more than 5 miles above the level of the sea.

The air is *not a chemical compound*, but a *mechanical mixture* of its constituents; for if oxygen and nitrogen are brought together in the proportions in which they are found in air, *no elevation of temperature, and no alteration in bulk*, take place (as is the case when gases combine chemically), and still the mixture acts exactly like air.

Again, when air is shaken up with water, some of it is dissolved, but it can be easily expelled by boiling; upon analysis the expelled air is found to consist of oxygen and nitrogen in the relative proportions of 1 to 1·87. It would have been quite impossible to decompose the air by simply shaking it up with water if it had been a chemical compound; *the compound would have dissolved as a whole*, and, upon analysis, the air expelled by boiling would have consisted of oxygen and nitrogen as 1 to 4, the proportions of the original air.

The air is therefore only a mixture, since a larger amount of oxygen is dissolved than corresponds to that contained in the atmosphere, a fact due to the greater solubility in water of oxygen over nitrogen.

The amount of carbonic acid increases with height; but it has been observed that oxygen frequently, at great elevations, is less than at lower levels. Mountain air appears to contain very little organic matter, and less oxygen and carbonic anhydride than lowland air.

OZONE.—This is an allotropic modification of oxygen: it may be called *condensed* oxygen, since it is found that this substance is one and a half times as heavy as oxygen—*i.e.*, three volumes of oxygen condense to form two volumes of ozone, one of the volumes being in a different condition of polarity to the other two $(\overset{-}{O}\ \overset{+}{O}\ \overset{-}{O})$. Ozone is a gas having a peculiar, strongly oppressive odour, which is perceptible when an electrical machine is at work. It was discovered by Schönbein, in 1840, who stated that it destroyed any organic matter which might be floating in a room.

Ozone may be artificially formed by passing a series of electric sparks through air or through damp oxygen; by allowing a stick of phosphorus to hang in a bottle filled with moist air, and by the electrolytic decomposition of water acidulated by sulphuric acid.

The chief source of ozone, however, is the electricity of the atmosphere; and the supposed sulphurous odour said to acccompany a thunderstorm is stated to be caused by it. Tidy states that the maximum quantity of ozone in the air never exceeds $\frac{1}{100000}$

part of its bulk. This substance has the power of setting iodine free from iodide of potassium; hence, paper impregnated with starch and iodide of potassium is turned blue by ozone.

In **Houzeau's Ozonometer** the litmus, slightly reddened, and soaked in iodide of potassium, is rendered blue by ozone. Ammonia gas also produces this reaction ; but reddened litmus, not impregnated by the iodide of potassium, is rendered blue by ammonia; this is not the case with ozone.

IMPURITIES OF AIR.

These may be divided into two groups:—

1. **Suspended Matters.**—Such as bacterial germs, plant-spores, particles of carbon from factories, and materials employed in various industries, and many other substances.

Dry Fog results from a stagnant and dry condition of the atmosphere, which becomes filled with dust and smoke.

The air of sick rooms, in which the ventilation has been imperfect, has been found to contain so much organic matter that, after collecting and burning it, the odour of burnt horn has been evolved. Arsenical particles from green flock-papers have produced several cases of poisoning. The dust of grinding-shops contains numbers of minute particles of iron, and by its constant inhalation establishes the so-called grinder's rot. The sputa in "coal-miners' phthisis" are frequently black from the inhalation of carbon particles.

The mycelium of the fungus tricophyton has been detected in the air of a ward in which some cases of children affected with tinea circinata were contained. Slides moistened with glycerine were employed for collecting the dust of the ward, and they were then examined microscopically.

2. **Gaseous Substances.**—These include ammonia, hydrochloric acid from alkali works, sulphuretted hydrogen, sewage gases, carburetted hydrogen, vapours from vegetable and animal bodies, from slaughter-houses, soap-boilers, bone-boilers, and glue-makers, and the poisonous fumes from brass foundries and copper-smelting works.

DISEASES originating from, or aggravated by, impure air.—Amongst these are headache, anæmia, grinders' and miners' phthisis, ordinary pulmonary phthisis, typhus fever, a form of chronic bronchitis, hospital gangrene, granular conjunctivitis, erysipelas, pyæmia, mal-developments, general malaise, and a feeling of being out of health without any definite malady. Jail fever and death have also resulted from dense overcrowding.

PURIFICATION OF AIR.

The materials employed for this purpose are the following:—

SOLIDS.—Some substances act upon air chemically. **Charcoal;** used to purify the air derived from cesspools and drains.

It should be kept very dry. **Unslacked lime** is used for the absorption of carbonic acid in wells. **Sulphate of copper** removes the smell of sulphuretted hydrogen, and is also valuable for treating the typhoid stools.

LIQUIDS.—Nitrate of lead solution removes the odour of sulphuretted hydrogen from cesspools. **Chloride of zinc** solution (Burnett's Fluid) is destructive to organic matter. **Permanganate of potassium** (Condy's Fluid) also destroys organic matter, absorbs sulphuretted hydrogen, and decomposes ammoniacal compounds. **Chromic acid** is also considered an important antiseptic; it is obtained by acting with sulphuric acid upon potassium dichromate.

VAPOURS AND GASES.—Chlorine destroys animal matter in the air, and decomposes the sulphuretted hydrogen and ammonium sulphide. **Carbolic acid** covers odours, arrests putrefactive changes, and the growth of fungi, but does not appear to destroy them. **Nitrous acid** acts upon organic matter, but must be employed cautiously, as it may produce severe irritation of the lungs. **Sulphurous acid** destroys organic matter, and has also been stated to destroy miasms. **Iodine vapour** arrests putrefaction, but it is inferior to chlorine.

Bromine Vapour acts like iodine, but the vapour is exceedingly irritating. **Euchlorine** is a substance obtained by the action of strong hydrochloric acid upon chlorate of potassium; its action is similar to chlorine, but it is not so irritating to the lungs.

EXAMINATION OF AIR.

The air is collected in clean glass jars, which hold about one gallon. The air is blown into the jars with a pair of bellows, of which the nozzle reaches to the bottom of the jars.

The substances looked for are the following, viz.:—Suspended matters, organic matters, carbonic acid, watery vapour, and ammonia.

The Suspended Matters.—These are detected by the microscope, the air having been drawn previously through an aspirator over glass slides, which had been moistened by glycerine, all the solid matter suspended in the air being thus collected upon them.

The Organic Matter.—This is determined by solution of potassium permanganate, through which is drawn a definite amount of air, the quantity of undecomposed permanganate of potassium being estimated by oxalic acid as potassium oxalate. By this process the amount of oxidisable matter (present in different samples of atmospheric air) only is indicated; it gives no indication of the source of this oxidisable matter. The same reaction is yielded by nitrous, sulphurous and other acids present in the air, and therefore the test is useless as indicating the absolute presence of *organic* matter.

The Carbonic Acid.—This is detected by the degree of milky coloration that it gives with a standard solution of lime or baryta water. If the air contains less than ·03 per cent. of carbonic acid, no precipitate results.

The Watery Vapour.—This is ascertained by various forms of hygrometers.

The Ammonia.—The amount of this substance is shown by Nessler's test (see pages 101, 102, 178).

Before performing this test, the air should be drawn through distilled water, which has been tested previously to show its freedom from ammonia.

OVERCROWDING.

After having been once breathed, the air is deprived of about 5 per cent. of its oxygen, acquiring instead about 5 per cent., or less, of carbonic acid gas, a large quantity of aqueous vapour, and a small amount of organic matter. The characteristic and disagreeable odour of crowded rooms, hospital wards, and bedrooms, when improperly ventilated, is due to this organic matter, which is dangerous to human life.

When the amount of carbonic acid gas in a room has been increased by breathing to 7 parts per 10,000, organic matter is present in an injurious quantity. The organic matter increases as the carbonic acid is increased, and, therefore, the quantity of this latter substance present in a room may be taken to indicate the organic impurity of the air vitiated by respiration alone.

In order to keep the air pure, at least 3000 cubic feet of air are required by each adult per hour, and, in confined spaces, at least 800 to 1000 cubic feet of space are necessary for each person. If 1000 cubic feet of space is allowed for each individual, the air must be changed three times during the hour, so that the necessary amount of 3000 cubic feet may be supplied.

Supposing the space to be only 500 cubic feet, the change in the air will have to occur six times in the hour, with the production of unbearable drafts.

To test the purity of a room, the smell should be noticed, whether stuffy or close. Before giving an opinion upon this point, the individual should have been previously in a pure atmosphere for at least a quarter of an hour.

Angus Smith's method is the following :—A wide-mouthed bottle is taken, which is capable of holding 10½ ounces of water. In it is placed half an ounce of lime-water; it is now allowed to become filled with air in the room desired to be tested. The mouth of the bottle is then closed, and the lime-water freely agitated by shaking. The bottle, of course, contains a volume of air which is equal to 10 ounces of water; if in this volume of air more than 6 parts per 10,000 of carbonic acid gas (CO_2) are contained, the lime-water will become milky.

As regards the number of persons that should be allowed to sleep in a room, the very smallest quantity of air that should be apportioned to each person should be 400 cubic feet.

The length (l), breadth (b), and height (h) of the room should be measured. These should be multiplied together to obtain the cubic contents. The product should be divided by 400, and the number of persons that may be allowed to sleep in the room is represented by the quotient, thus $\frac{l \times b \times h}{400} =$ number of persons allowable.

Example: A room is 16 feet long, 10 feet broad and 10 feet high; then $16 \times 10 \times 10 = 1600$: and $\frac{1600}{400} = 4$.

The cubic space required by the Poor Law Board for dormitories is as follows :—

Healthy	300	cubic feet
Infirm, with separate day-room	500	,, ,,
Infirm, same room day and night	700	,, ,,
Sick	850	,, ,,
Lying-in cases and offensive sick	1200	,, ,,

VENTILATION.

The following important points must be borne in mind in dealing with the question of ventilation, viz. :—

The capacity of the room, *i.e.*, the amount of cubic space contained in it.

The efficiency of the means for allowing of the entrance of pure air and the escape of the vitiated.

The number of individuals present in the room normally.

Allowance must be made for the number of lamps, candles, gas-jets and fireplaces.

Capacity of the Room.—In calculating the cubic space of an apartment, the breadth, height, and length should be multiplied together, making allowance for any cupboards and recesses, and for the bodies of the occupants, giving an average of three cubic feet for each individual. The cubic space occupied by a man is obtained by taking his weight in stones and dividing by 4.

If the shape of a room is irregular, it should be divided into several imaginary squares or triangles; the sum of these gives the size of the room. When these allowances have been made, the remaining number of cubic feet divided by the number of individuals indicates the cubic space per head.

Sufficient air should be supplied to each individual, so that the amount of carbonic acid in the air of the apartment should not exceed ·6 per 1000 volumes; the quantity of carbonic acid present indicating the amount of organic impurity, allowing for ·4 of carbonic acid, which exists naturally in the atmosphere.

·4 per 1000 is the normal proportion of carbonic anhydride in air.

·6 per 1000 is the limit of health ; and

·1 per 1000 will be evident to the senses.

The entering air should be pure, of the proper temperature, and its supply must be at the rate of 3000 cubic feet per head per hour. There should be no draft. When the air is changed oftener than six times in the hour, a draft is produced.

The air should be diffused through the room, and should not be allowed to remain stagnant in any part. Means must be provided for the entrance of the pure air and the escape of the foul.

NATURAL VENTILATION.—Under this head are included the causes which operate naturally by removing foul air and introducing pure air, independently of any mechanical means—viz., the expansion of air by heat, the force of the wind, and the diffusion of gases.

The air of a room which has become heated by respiration and by its contact with the human body, becoming simultaneously vitiated by the products of respiration, ascends to the upper part of the chamber, and escapes by any outlet with which it may meet. A vacuum is thus formed; a rush of cold air takes place from any opening near the ground, such as the chinks of windows and doors, and by these natural means ventilation is established.

In a similar manner fires in open grates act; a strong upward current is created by the rush of warm air up the chimney, its place being supplied by the cold air from below.

Our modern fireplaces ventilate only as high as the opening into the chimney; the air above the mantelpiece for the most part remains stagnant. Chimneys without fires are useful ventilators. In consequence of the wind blowing over their tops, a partial vacuum is occasioned, this vacuum being filled constantly with the air from the house, and resulting from the aspirating power of the wind.

Smoky Chimneys.—The following are some of the causes of these:—If in one room there are two fireplaces, the one in which no fire is may produce a down-draught in the other.

Fires lighted in the grates in the top rooms may draw the air down through the chimneys which open into the lower rooms.

When a fire is lighted, if sufficient air is not admitted to the room to feed the fire, a down-draught results. When a chimney is commanded by higher buildings, the wind passes over them and is directed down the chimney. If the flues are too high for the size of the fire, the heat is insufficient to make hot the whole column of air; thus there is but little draft to carry away the smoke, which will therefore enter the room.

Practically, the natural modes of ventilation do not suffice for the demands of thorough ventilation. The air may be as hot outside as inside the house, in which case a dead calm may result.

A window may be readily employed as a ventilator by opening it and inserting a piece of board (some 6 inches in length, and the full width of the window) beneath the bottom sash, which is then closed down on it. An air space is thus left between the two sashes, the entering air being directed towards the ceiling, and, in consequence, diffused more equally. In dormitories a partial opening of the windows during a winter night is quite as desirable as during a summer night; for, if there is not sufficient difference of temperature between the outside and inside, the watery vapour which the sleepers exhale condenses upon the walls, the pores becoming obstructed. A part only is evaporated during the day, and consequently the breaking out of damp spots in such dormitories is of no infrequent occurrence.

ARTIFICIAL VENTILATION.—The following methods are employed:—

Sylvester's Method.—In this the agency of the wind is utilised by means of a cowl, which is directed constantly towards the quarter whence the wind blows. Pipes distributed throughout the house are connected with this cowl, and through these pipes fresh air enters the various apartments. In connexion with another cowl turned from the wind, is another system of pipes, and by these the hot vitiated air is removed. The objections to this system are (especially upon sailing-vessels, in which it has been extensively employed), that during a calm the cowls are almost valueless, and that, if the wind is high, the amount of air admitted is incapable of being regulated so as to maintain a suitable temperature or to obviate drafts.

Pott's Method.—Here a tube, divided into an upper and lower compartment, is placed behind the cornice of a room; in each compartment small holes are pierced. The upper is connected with the chimney or other hot-air shaft, and the lower by joined pipes with the external air. The pure air is supposed to obtain entrance by the lower compartment, and to sink gradually to the floor, the products of respiration escaping by the other compartment.

Tobyn's Method.—The air is conveyed into the room by means of tubes, which are placed vertically in the walls, the openings in the room being situated about 6 feet from the floor. It is said that the air being admitted into the room over the heads of the occupants, all draft is avoided, and the air perfectly renovated. The inlet and outlet should be in size about 24 square inches per head.

Ventilation by Extraction.—The apartment to be ventilated is connected by means of tubes with a ventilating-shaft; at the bottom of this shaft a fire is kept burning. An upward current results, which is fed by the air from the tubes.

As fast as the vitiated is removed, the pure air, which has been carefully warmed, is admitted to the room. Mines are ventilated upon this principle by the *upcast* and *downcast* shaft. Air enters the mine through the downcast shaft, which is connected with the galleries, so that the air first circulates through the mine, then passes out by the upcast shaft, a fire being kept burning at its bottom.

By this method steamships are also ventilated, merely by connecting the various parts of the ship with a tube placed above the furnace fires. Among the objections to this method are the following:—That the draft is unequal, since it is difficult to keep the fire always at the proper height; that the movement of the air is also unequal in the various rooms, since those which are nearest to the shafts are more rapidly exhausted than those which are at greater distances; that smoke regurgitates from the shaft into the room; and that it is difficult to control the supply of fresh air at the right temperature.

Ventilation by Propulsion.—This is known as the **Plenum Method**, and consists in forcing in the air by the aid of a fan-wheel which is enclosed in a box. Air can be drawn out of the chamber by simply reversing the action of the wheel.

WATER.

Good drinking water should be without colour, without taste, or very nearly so, and without odour. It should be obtained from some well-known uncontaminated source, and upon evaporation it should yield little or no residue. In it no undue quantity of solid constituents should be present, especially the salts of calcium and magnesium. Per gallon, the amount of solids should not be more than 8 grains, and of those one grain alone should be dissipated by heat. In the chalk waters the solids should not exceed 14 grains per gallon. The albuminoid ammonia should be less than 0·05 per million; a water which, in company with a considerable amount of free ammonia, yields ·05 part of albuminoid ammonia per million must be looked upon with suspicion.

Water Storage.—The water is first collected in a large reservoir, and then passed into filters, consisting of brick tanks open to the air, having their bottoms covered with four or five feet of coarse gravel and sand, arranged in the following order, from the bottom upwards:—A layer of bricks 6 inches in depth; next, 6 inches of gravel; lastly, a layer of sand 2 feet 6 inches in depth.

By this arrangement a filtration is allowed of 4·5 cubic feet per hour.

After filtration, in order to protect it from contamination and from the sun, the water should be preserved in covered reservoirs.

For **Private Storage**, cisterns of slate, iron, zinc, and lead are used. Those of slate are the best; the most commonly employed are made of zinc, since this material is the cheapest. It is difficult to keep a slate cistern water-tight; when iron is used this metal should be coated with the patent material used for water-mains.

Free ventilation should be provided; but every cistern should be kept well covered in order to avoid any contamination.

Care should be taken that the **waste-pipe** communicates with the open air and that it has no connexion with the closet-trap or with the drains.

The following tables are given by the Rivers Pollution Commissioners and indicate the characters of the different varieties of water in common use :—

TABLE I.

Wholesome:	1. Spring water. 2. Deep-well water. 3. Upland surface water.	Very palatable.
Suspicious:	4. Stored rain-water. 5. Surface water from cultivated land.	Moderately palatable.
Dangerous:	6. River water to which sewage gains access. 7. Shallow-well water.	Palatable.

TABLE II.

Waters arranged according to softness :—

1. Rain water.
2. Upland surface water.
3. Surface water from cultivated land.
4. Polluted river water.
5. Spring water.
6. Deep-well water.
7. Shallow-well water.

TABLE III.

Waters arranged according to the efficiency of their filtration in passing through various geological strata :—

1. Chalk.
2. Oolite.
3. Green sand.
4. Hastings sand.
5. New red and conglomerate sandstone.

The commonest solid ingredients of natural waters are sulphate of calcium and carbonate of calcium, held in solution by an excess of carbonic acid, and giving to water the property of "hardness." The terms hard and soft are applied to water according to its action on soap.

In a hard water the contained earth (magnesia or lime) unites with the fatty acid (stearic or oleic) of the soap, forming a new substance, insoluble in water.

Boiling renders a hard water soft, since the carbonic acid is driven off, and the carbonate of calcium is precipitated. The hardness destroyed by boiling is called "temporary" in contradistinction to the "permanent hardness" caused by salts of magnesium and calcium, and which is still present in a boiled water.

A **"Soft Water"** is one below 6 degrees of hardness; each degree of hardness destroys 2½ ounces of soap in each 100 gallons of water employed in washing.

Commercially, soft water is more valuable than hard water in proportion to the worth of 5 ounces of soap to each 200 gallons for each degree of hardness.

Degree of Hardness.—This term implies that a given volume of water decomposes a certain number of cubic centimetres of the standard soap test.

Each C.C. equals one degree of hardness; thus, "10 degrees of hardness" means that 10 C.C. of the soap solution have been employed.

Clark's soap test for the hardness of water is the following:—To the water a standard solution of Castile soap in alcohol is added. If the water is soft, a lather is instantly formed; but should any quantity of lime, magnesia, alumina, or baryta be present, the formation of the lather is retarded.

Formation of Ice.—Water, when *heated* from 0° C. to 4° C. contracts; on *cooling*, from 4° C. to 0° C., it expands again; above 4° C., it follows the ordinary law of expansion by heat. Thus, we say that the *point of maximum density of water is* 4° C.—*i.e.*, a given bulk of water will weigh more at this temperature than at any other. In the freezing of large lakes and rivers, the cold winds gradually cool the surface-water, which, becoming heavier, sinks, and lighter and warmer water rises in its place. This process goes on until the temperature of the whole mass is reduced to 4° C., and then the surface-water no longer sinks, since it is always lighter than the deeper water at 4° C. Ice is formed only at the top, the mass of water retaining a temperature of 4° C. If water became heavier as it cooled down to the freezing-point, a continual circulation would be kept up until the mass was cooled to 0° C., when solidification of the whole would take place. Sea-water rarely, if ever, freezes *en masse*, on account of the great depth of water which prevents the whole being cooled down to the freezing-point.

On the tops of mountains water *boils* at a temperature below 100° C., because the atmospheric pressure is less than at the sea level.

To obtain *pure* water, we are obliged to *distil* river or spring water—that is, we boil the water and collect the fluid formed by the condensation of the steam produced. Thus, the solid matters are left behind. Rain-water is the purest form of water in Nature, but even this may contain foreign matters. Sea-water contains about thirty-five parts of solid matter (twenty-eight parts consisting of sodium chloride or common salt) in solution, in 1000 parts of water.

Action of Water on Lead.—In dry air, the surface of the metal remains bright, but in moist air it soon tarnishes from oxidation; and the oxidising process proceeds rapidly if a small quantity of weak acid, such as carbonic or acetic acid, is present. Lead preserves its lustre in pure water freed from air; but should air be present, then oxide of lead is formed, and by the solution of this in water successive portions of the metal are exposed for oxidation. Waters containing *nitrates* and *chlorides*, or much *free carbonic acid*, are *prone to impregnation* with lead, but the hard waters in which are *sulphates* and *carbonates* may safely be brought in contact with the metal, since a thin deposit of carbonate or sulphate of lead is formed, which prevents further action.

To test for the presence of lead in water, a gallon of the water should be evaporated to a small bulk; it should then be acidulated, and a stream of sulphuretted hydrogen passed through, when, if lead be present, a brown colour or black precipitate is occasioned, according to the amount of the lead present.

Diseases traceable to Impure Water.—Typhoid fever, dysentery, cholera, diarrhœa, ague, and other malarial fevers, goître, stone in the bladder, and lead-poisoning have been traced to a contaminated water-supply. The first three affections are spread by the fact of the excreta of the affected persons getting into the drinking-water.

Diarrhœa may arise from the water containing an excess of magnesium salts or decaying vegetable and animal matters. Goître is said to be caused chiefly by drinking water which has passed through magnesian limestone (dolomite) or carbonate of magnesium and calcium. Lead-poisoning may result from water becoming contaminated in its passage through leaden pipes, or from being stored up in leaden cisterns. Serious symptoms have resulted from $\frac{1}{9}$ of a grain of lead per gallon, and even from $\frac{1}{20}$ or $\frac{1}{25}$ of a grain per gallon.

For **medico-legal purposes** the important **impurities of water** may be divided into three groups, viz.:—

1. Impurities detracting from the use of water for washing purposes. Very hard water, especially if the hardness be permanent, is wasteful as regards soap.

2. Impurities rendering water disagreeable rather than dangerous when used for domestic or drinking purposes.

Chalybeate, sulphurous, and most medicated or mineral waters are included under this heading.

3. Impurities making water dangerous or undesirable for drinking or domestic purposes.

(*a*) Certain mineral impurities, as a large amount of chlorides, nitrites and nitrates, which, although themselves harmless, may show contamination with sewage or decaying vegetable and animal matters.

(*b*) Poisonous mineral constituents—viz., antimony, arsenic, lead and barium salts, which may be derived from manufactures, or from the constitution of the soil through which the water percolates.

(*c*) Decomposing animal and vegetable matters generally indicated by the smell, taste, and colour, or by permanganate of potassium and other reagents.

(*d*) Deleterious gases, vapours, and solid particles derived from graveyards, sewage, &c.

Fungi, infusoria, sulphuretted hydrogen, and other gaseous compounds of sulphur, carbon, phosphorus and hydrogen, are included *under this heading.*

The **TESTS** for the chief impurities of water are the following:—

Hardness.—The standard soap solution.

The relative degree of hardness of any sample of water may be judged roughly by placing a small quantity in a *test-glass*, then adding to it a few drops of a standard solution of soap in alcohol, upon which a white turbidity will result, according to the degree of hardness of the water.

Organic Matter.—This should be decomposed, and tested for ammonia by Nessler's test.

Nessler's test consists of a solution of perchloride of mercury, iodide of potassium, and liquor potassæ, and is adopted from the fact that, when to water containing ammonia is added a saturated solution of iodide of mercury in iodide of potassium (made strongly alkaline by caustic potash), various brown shades of colour are produced.

If these shades of colour are compared with those produced in standard solutions of ammonia, the quantity of ammonia that the sample of water contains may be estimated.

Permanganate of Potassium in solution, when added to water, is deprived of its beautiful crimson colour if any organic matter is present.

Chloride of Gold precipitates a black or violet powder if much organic matter exists in a water.

Chlorides.—With these, nitrate of silver gives a white precipitate soluble in ammonia.

If nitrate of silver produces a copious white precipitate in any sample of water, this must be considered suspicious.

Sulphates.—Hydrochloric acid and chloride of barium give a white turbidity varying in quantity according to the amount of sulphates present.

Nitrates.—Sulphuric acid and pyrogallic acid give a pink-blue colour changing to brown.

Nitrites.—Sulphuric acid, pure iodide of potassium and freshly prepared starch solution give a blue colour.

Lead or Copper.—Hydrochloric acid and sulphuretted hydrogen give a black or brown precipitate.

Very little **Chlorine** should be contained by a good drinking water, unless an explanation of the presence of this substance is afforded by the source of its supply being near the sea, or by the geological nature of the formation from which it is derived. An abnormal amount of chlorine may be an indication of sewage contamination. When it is accompanied by organic matter and free ammonia, the contamination is recent, and possibly dangerous; when associated with nitrites and nitrates, the danger is not so great.

Organic Matter should not be present in any quantity, and except in the case of peaty waters, when the origin is evidently vegetable, must be regarded with suspicion, especially when accompanied by an abnormal amount of chlorine and free ammonia.

Nitrites and Nitrates must be considered suspicious except in waters derived from the chalk, and in deep well waters; their presence in shallow well waters proves the existence of a contamination which may assume a dangerous nature.

Sulphates in excessive quantity (unless associated with special geological characters by which any abnormal quantity might be accounted for) in conjunction with ammonia, organic matter and chlorides afford positive evidence of sewage contamination.

Ready-formed Ammonia in any recognisable quantity in a water must be considered suspicious, and the simultaneous presence of chlorides and organic matter affords corroborative evidence.

Water is **Purified** by the following methods :—

1. **Filtration.**—This may be performed by the water being passed through layers of charcoal and sand.

2. **Boiling.**—This is the most satisfactory when the water is thought to contain organic impurities. For the destruction of germs, long-continued boiling is less effectual than intermittent boiling—*i.e.*, the water being boiled for short periods, with intervals between.

3. Addition of **Certain Substances.**—Clark's process for rendering temporarily hard water soft consists in driving out lime by lime —*i.e.*, adding lime-water to the hard water. Carbonate of calcium is formed by the union of the lime with the free carbonic acid gas, and this new-formed carbonate, together with the carbonate previously dissolved, is precipitated.

For the removal of suspended organic or inorganic substances, alum has been found serviceable.

In order to oxidise the organic matter, Condy's Fluid is occasionally employed.

SEWERS AND DRAINS.

Sewers may be made either of brick or earthenware

Drains are usually earthenware pipes, which have been properly glazed inside. For houses the diameter of a drain may vary from 4 to 6 inches.

Certain points have to be considered in the construction of a sewer—viz., the best shape, the external pressure that it has to bear, and the minimum velocity required. Circular sewers are the best when the flow is large and constant; but the oval form should be selected when the flow is intermittent, in order that with the smallest volume of sewage the greatest velocity should be ensured. Up to 18 inches in diameter a circular sewer is best made of concrete or earthenware.

Every public sewer should be at least 9 inches in diameter. A sewer built of brick should be egg-shaped or elliptical, and should be well cemented, its smaller end placed downwards, provision being made for sub-soil drainage, so that no soil-water may percolate into it. Man-holes should always be interposed at the junction of sewers. If possible, sewers should always be laid in straight lines, and any necessary curves should never be less than ten times the cross-sectional diameter of the sewer. Every sewer should be laid at a sufficient depth to be below all cellars, and it should never be permitted to be more than two-thirds full. The more acute the angle of entrance of the sewage the better, since there is the tendency, with junctions at right angles, for the inflowing sewage to create eddies which obstruct the main current. All T joints should be avoided and Y joints substituted. The junctions from house-drains should be made so that any discharge from them passes in the direction of the established current. In making a sewer, storm-waters must be allowed for, and therefore intercepting sewers must be provided.

Man-holes and Lamp-holes should be placed at such distances as will permit of easy access for the cleansing and ventilation of the sewer, and they should be furnished with ventilating chambers filled with charcoal. A lamp-hole consists of a small shaft in which a lamp can be suspended, and which can be seen from a man-hole in the sewer. The lamp-holes and man-holes should act as ventilators, and they should be placed at every vertical point of deviation of the sewer. The man-holes should also be placed at every point of lateral deviation.

The Cleansing of Sewers.—Sewers should be constantly cleansed, either by flushing (the most economical method) or some other means, since, in consequence of the ever-varying level of the flow, a considerable quantity of putrescent matter adheres to their sides and tops.

Ventilation of Sewers.—Several methods have been tried; one by open gratings in the street in communication with the sewers; another method, by placing traps containing charcoal in the man-holes, in order to intercept the rising gases. An attempt has also been made to ventilate sewers by means of pipes, connecting them with the furnaces of soap works. All these plans have failed. The most successful method would seem to be to connect the sewers with pipes which are conveyed above the tops of the houses, either with an Archimedean screw or with a Boyle's ventilator at their tops.

Little ventilation is necessary if the sewers are flushed daily or have a good fall.

Obstruction to Sewers may be caused by improper levels being used, by too little fall, by bad connexions, or by too sharp curves, by imperfection in the making and laying of the sewers (resulting in sinking of the floor), and, lastly, by impediments at the mouth of the sewer, due to accumulation of excreta and mud, backward pressure of sewage, caused by wind and tides, and from the need of proper water-supply for the periodical flushing of the sewer.

House Drains.—When inside the house, these drains should be constructed of cast iron, smooth on the inside, the joints being made of caulked lead, having a sufficient fall to render them self-cleansing.

When outside the house, and the soil is unyielding, pipes of glazed earthenware may be used, the joints being fixed by hydraulic cement; but care must be taken that no cement juts out from the inside and thus creates obstruction. For the joints of drains clay should never be employed, since it is very apt to shrink and crack and become useless. A foundation of concrete is requisite, on which the drain-pipes should be laid, in order that no portion of the pipes may settle and the joints become opened.

In the bed of a drain-pipe trench a recess should be cut for the reception of the socket of the pipe, and for the packing, cement should be employed.

Traps.—For a good house drain, good traps are necessary. The best trap is that known as the **Syphon Trap,** or ordinary S bend.

The causes that may render this inoperative are the following:—

The pressure of the air in the sewer may force it; the water absorbs the sewer gas, and then gives it out on the opposite or house side.

In traps that have not been used for some time the water may have evaporated partially and thus leave the trap useless.

The curve may not be sufficiently deep to allow a certain depth of water to stand above the highest level of the water in the curve. When sufficient water is not used to cleanse the trap thoroughly, it is apt to become clogged, and to allow foul gases to rise from it into the house. The trap is liable to be sucked dry, if the pipe is small (2 and 4 inches), by the syphon action of the pipe beyond. This occurrence is most likely to happen when there is a sudden rush of water through the trap, and the pipes are running quite full. Again, if several syphons are employed in the course of a drain, they may be sucked dry by their combined action. For example, A, B, C are three syphon traps placed in the line of a drain; if the supply of water is suddenly cut off from the drain when running quite full, a vacuum is established between A, B. C; B will consequently untrap A, and C will untrap B, C itself being untrapped on the one side by the vacuum and on the other side by the force of the air. To obviate this unsealing action, it is necessary to place ventilators between the traps.

Amongst other traps are the following:—

The **Mid-feather Trap.**—A syphon trap having a projection from the inner surface of the shorter curve of the syphon, and which dips into the water in the trap.

The **Flap-Trap.**—Simply a hinged flap, allowing the water to pass only one way. This trap closes by its own weight. It is employed for closing the mouth of drains, to arrest the entrance of water or wind, thus preventing regurgitation.

Bell Traps.—These should always be avoided. They are the usual sink-traps.

D traps also never should be made use of.

A means of access to the drain-pipes should be provided, if possible. in order to ensure their periodical cleansing.

Each water-closet should have a separate water-cistern for its supply, and should be placed on an outside wall, as far as possible away from the main building, in a lobby or turret, and provided with plenty of ventilation and light. The scullery-pipes, if possible should not open into the soil-pipe, since the drain may become clogged by chilled grease. In all cases a receptacle for the grease should be provided. The rain-pipes, bath-pipes, and every other pipe may be discharged over a grating into the open air.

Tests for the Soundness of House Drains.—Upon drawing up the closet handle, if a flush of water passes the disconnecting trap outside the basement, the drain is pervious.

If the trap is stopped up, and the pipe in the basement is filled with water, should the water remain for some time at the same level, there is no leak in the pipe.

If oil of peppermint or paraffin be passed in at the lowest part of the drain, and after a time each room is visited, should no odour of these materials be observed, the traps and joints are sound.

WATER-CLOSETS.

The following are in use:—

The **Pan Closet.**—This is the most commonly employed, but it is the most dangerous and defective. It consists of a funnel-shaped earthenware receptacle, placed under the seat of a copper pan, which contains water and closes the smaller end of the funnel. When it is necessary to empty the pan, this is tilted obliquely downwards by a lever. A cast-iron box or receiver rests on the floor, and in this the contents of the pan are thrown; below the floor is placed a short pipe with a lead trap.

This form of closet is open to the following objections:—The receiver becomes filthy, since from its position it cannot be cleaned; the trap being below the floor, obnoxious gases are generally emitted from the contents, and these are forced upwards on every occasion that the pan is tilted, its contents being poured into the trap. A large reservoir of foul air is formed by the receiver, and this empties itself into the room upon tilting the pan.

The Hopper Closet.—This consists of an earthenware funnel having a lead syphon trap, or with an earthenware trap in one piece, attached to which is a ventilating-pipe.

The advantages claimed for this closet are that there is no reservoir of foul air, as is the case with the pan-closet, and that it can be cleaned easily. The objections are that the trap-contents are directly exposed, and it is therefore necessary to flush it out directly after use; that much waste of water may ensue from carelessness,—this may, however, be prevented by having a separate tank which contains sufficient water for each flushing.

The supply of water for these closets should come direct from the mains.

The Jennings Closet.—This possesses the advantages of the

Hopper Closet, and has none of its objections, these being provided against by the adoption of a hollow plug which, when lifted, allows of the rapid discharge of all fæcal matter, and, when down, of the retention of a considerable quantity of water in the closet-basin. This is no foul reservoir, as in the Pan Closet, and also a large water-trap is provided, with less waste than in the Hopper Closet.

The Bramah Closet.—This is a valve-closet, furnished with a receiver only of sufficient size to permit of the full action of the valve. The receiver presents the same disadvantages as the ordinary Pan Closet.

DISPOSAL OF SEWAGE.

The following methods are employed:—

A. THE DRY METHOD.—This includes the following:—

1. **Moule's Dry Earth Closet.**—Closets filled with pans, in which dry earth is contained.

2. **The Charcoal Closet.**—The pans filled with charcoal.

3. **The Goux System.**—The excrement is collected in tubs 16½ inches, and 20 inches wide at the top, and lined with dry absorbents. On the bottom, dry stable-sweepings are placed, a solid plug, about 4 inches smaller than the tube in every direction, being placed upon this. More dry stable-sweepings are packed into the space between the plug and sides of the tub, the plug being then removed.

4. **The Ash Closet.**—The ashes from house fires are used. There are several objections to all the above.

B. THE WET METHOD.—This includes—

1. **Emptying the sewage** into the sea or a neighbouring river.

2. **Addition of Disinfectants** and other substances in order to precipitate the solid matter, and letting the liquid part flow into the sea or river.

3. **Employment of the sewage** for fertilisation purposes by means of irrigation.

4. **Filtration.** Upward and downward filtration through gravel, sand, sawdust, and charcoal.

Upon the whole, the water-carriage system is the best; but, to be carried out with success, it demands a good supply of water, good sewers and drains carefully ventilated, a sufficient fall to communicate to the current the needful velocity, a good sub-soil drainage apart from the sewers, and a method of utilising the sewage.

DEFECATION OF SEWAGE.—The three best-known **Chemical Processes** are the following:—

1. The **Phosphate of Aluminium** Process.—The sewage is precipitated by native phosphate of aluminium (dissolved in sulphuric acid), and the subsequent addition of caustic lime. This is a very expensive process.

2. The **Lime** Process.—In proportion to the strength of the *sewage, a definite* quantity of caustic lime is added. All the ma-

pended matter is precipitated, together with a certain amount of the dissolved sewage constituents.

The **A B C** Process.—A mixture of **A**lum, **B**lood, **C**lay, and **C**harcoal is here made the precipitating agent, and from this circumstance the name is derived. A given amount of this A B C mixture is added to the sewage, which is then left to subside in precipitating tanks. After drawing off the clear liquid, the sediment is dried and sold for manure.

FOOD

is necessary for the development of the heat required to maintain the body, and also for the production of muscular and nervous power. It is absolutely necessary that the food shall be in a fit state for digestion, and that the secretions it encounters in the alimentary canal are in a healthy state for its digestion. Care must be ensured that variety shall be provided in the articles used as food, so that in them the proper dietetic proximate principles are contained.

Milk is said to contain all the ingredients necessary to support life.

The following classification is based on the chemical nature of the principles:—

1. Inorganic.
    - Water.
    - Saline substances, &c.
2. Organic
    - Nitrogenous—Albumen, &c.
    - Non-nitrogenous
        - Hydrocarbons or Fats.
        - Carbohydrates or Sugars.

Health can only be maintained by a due proportion of each constituent of food in the diet.

Dr. Letheby considered that an adult in active employment required daily about 7000 grains of carbon and about 400 of nitrogen; two pounds of bread and three-quarters of a pound of meat just about supply the amount of carbon and nitrogen required *per diem.*

The dietarics of women should be $\frac{1}{10}$th less than those of men.

For a child of ten years of age half as much food will be necessary as for an adult woman, and for one of fourteen years quite as much. Young men, when engaged in the same employment, demand about as much food as adult men.

It is important to provide variety, digestibility, relative proportions of proximate principles, number and distribution of meals.

ALCOHOL, according to Brunton, in small quantities assists digestion, and is useful in exhaustion; in large doses, impairs digestion; prolongs life on an insufficient diet. Although it does not impart additional strength, yet it enables an individual to draw upon his reserve energy, and may consequently be useful in a single effort, although valueless for prolonged exertion. Intoxication results from the nervous system becoming paralysed; the first structures involved are the cerebrum and cerebellum, then the spinal cord, and finally the medulla oblongata, death being caused usually by paralysis of the medulla.

Drunken men enjoy an apparent immunity from the usual effect of serious accidents, and this is due to the nervous mechanism becoming paralysed; in the sober state, shock to this mechanism would be produced.

MEAT.

When cut, good meat (mutton or beef) should present a marbled appearance, and its colour should be pale and slightly brownish red, neither too dark a purple nor too pale a pink. Pinkness and moistness indicate disease. Purpleness and lividity lead to the suspicion that the animal has suffered from fever, or died with the blood in it. The meat of a healthy *slaughtered* animal should be elastic and firm, possessing little if any odour; and, after keeping for a day or so, should dry on the surface. Bad meat may be recognised by its flabby and moist appearance, and by its sickly odour. On plunging a clean knife into the meat and putting it to the nose, the taint may be detected. The juice should be slightly acid

In cooking, good meat should not shrink or waste much.

Unsalted pork should in every way resemble other good meat, except with regard to its colour, which should be of a very pale red tint. A dark colour suggests the presence of the *Trichina spiralis*, in which case the meat should be examined with a magnifying-glass. The sac of the *Measle*, or *Cysticercus*, frequently the size of a hemp-seed, is easily noticed, especially in the psoas muscles. Sausages often become partially decomposed, and are then poisonous. Sound sausage-meat has a vesicular or moist gelatinous appearance, and is known by its firmness and the absence of any unpleasant smell.

BAD FOOD.—Articles of diet may be adulterated to an injurious extent. Water is frequently used to adulterate milk; leaves of other plants are mixed with tea, and the products of other cereals (starches) with wheaten flour.

Milk (unskimmed) should be of a full white colour, destitute of flocculi (curds) or deposit. When left to stand, it should yield about $\frac{1}{10}$th its volume of cream. The specific gravity ought to be about 1021 to 1032.

The specific gravity of skimmed milk is somewhat higher than that of pure milk.

Under the microscope, the various starches employed in the adulteration of flour will be recognised by the shape of their corpuscles.

In many cases of food that has undergone putrefaction, and in the flesh of diseased animals, the microscope will show parasites or bacteria, the Trichina spiralis, echinococcus, and other parasites.

Insufficient Food.—The general health speedily suffers. The prominent symptoms of slow starvation are feebleness, diarrhœa, emaciation, and a liability to attacks of acute disease.

Improper Food.—A notable cause of disease in infants is the administration of bad milk, and various kinds of patent foods. Diarrhœa, vomiting, and rickets may result.

With adults, the abuse of alcohol, irregularity in taking meals, and too much meat frequently cause ill health.

For great physical exertion a generous proteid diet is demanded; and much fatty food is required in cold climates, or when there is extreme cold.

When vegetable salts have been absent from the diet for any long period, purpura and scurvy may follow.

The state of the teeth is also important, since the want of mastication is a frequent cause of dyspepsia.

Infectious diseases may result from eating the flesh of animals affected with rinderpest, anthrax, pleuro-pneumonia, and the foot-and-mouth disease. Severe disorders have resulted from using as food the flesh of oxen treated with tartar emetic, and partridges fed on berries; also the milk of goats who have eaten colchicum has proved poisonous. Gastric irritation has followed from partaking of very high game, an acrid fatty acid occasionally being formed.

The following summary may be found useful:—

DWELLINGS.

Bedrooms.—In these the windows should open both below and above. Their size should be large enough to admit of at least 1000 feet of space for each adult occupying them. In each room there should be a fireplace, and the chimney in good order. The rooms should be constantly and well aired, and kept dry. No drain-pipes should open near or in the rooms. They should be kept, during illness, or when their occupants are infirm and aged, at as nearly a uniform temperature as possible. A good standard is 60° to 65° Fahr.

Sitting-rooms.—These should be airy, light, neither overheated nor cold, and they should be selected with as great an amount of cubic space as possible.

Kitchens.—Whenever possible, an underground kitchen should be avoided. The water supply and the drainage are of great importance.

Drains, Water-closets and Lavatories. — In houses which otherwise are well built, these are the principal sources of danger. The water closets, whenever possible, should be constructed entirely out of the house. The supply of water for the closet, and that for the house, should never be obtained from the same cistern. The cistern from which is obtained the supply of water for domestic uses should be covered in carefully; a constant supply of water is to be preferred to an intermittent one.

A ready access of sewer gas is occasioned by the fact of the waste pipes from the lavatory being in direct communication with the closet waste-pipes. Foul smells in a house are always suspicious; if a strongly smelling substance, such as oil of peppermint or carbolic acid (which has been poured into the drain outside the house), can be perceived inside, it is quite certain that sewer gas may find an entrance by the same route. The best methods of protection in such eases are efficient ventilation and frequent flushing of the drains and closets.

Water Supply.—The quantity of water supply to each person daily should be about 25 gallons, thus:—

For domestic purposes	12	gallons
Closets	6	„
Baths	4	„
Waste	3	„

Exercise.—Some amount of daily exercise in the open air is essential to the health of man and woman.

It is of no consequence in what form the exercise is taken, if it is taken regularly, avoiding excess; walking, running, sliding, swimming, and rowing are all of great value.

In some cases with a tendency to phthisis, notwithstanding every amount of care, the disease will come on; whereas, in other cases, by apparently running into danger—*i.e.*, exposure to cold and alternation of temperature—the disease has been averted. At one time warm and equable climates were selected for phthisical patients, but later opinions have considered the higher region of the Alps more suitable as being more bracing.

Daily Bath.—This improves digestion, circulation, and assimilation, promoting tissue-changes.

The cold bath is scarcely suitable for very young and delicate persons, and for them warm water may be added. One of the best modes of promoting sleep is daily sponging of the whole body, and this proceeding is of much value in cases of exhausting or febrile disease.

When available, the open-air bath is to be preferred by healthy and robust persons.

Disinfection.—Fresh air is of the greatest importance. For the disinfection of a newly vacated sick-room, the most commonly employed substances are chlorine, nitrous acid gas, and sulphurous acid gas. The room should be stripped bare of all woollen and similar materials. The wall papers should be removed and burned, and any opening by which air may enter should be closed by pasting over it brown paper. Sulphurous acid may be generated by burning sulphur—one pound to every one thousand cubic feet of space—in an earthen flower-pot or on a shovel over a tub of water. Upon freely generating the gas the room should be closed, and exposed to the action of the disinfectant for at least twelve hours. Afterwards the room should be freely exposed to the external air, the floor and wood-work thoroughly scrubbed, everything washed with diluted carbolic acid solution (one part of acid to forty of water or more) a good fire lighted in the grate, and, lastly, the ceiling should be whitewashed and the walls of the room repapered. For outdoor purposes chloride of lime is much used.

The application of **dry heat** is peculiarly suitable for purifying clothing of all kinds, and kilns for applying heat to such materials on a large scale are to be found in all large towns. The substance required to be thus disinfected is first placed in some soluble disinfectant, and subsequently baked for an hour or so.

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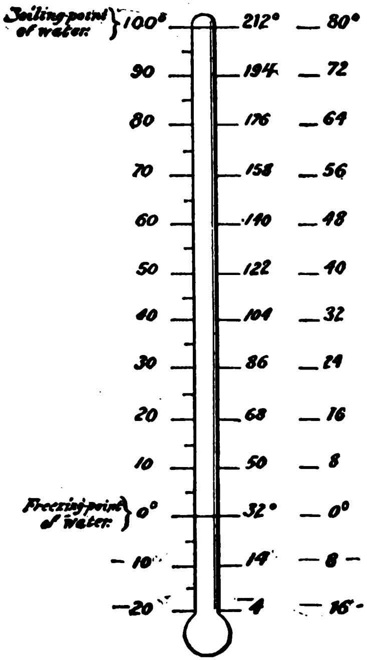

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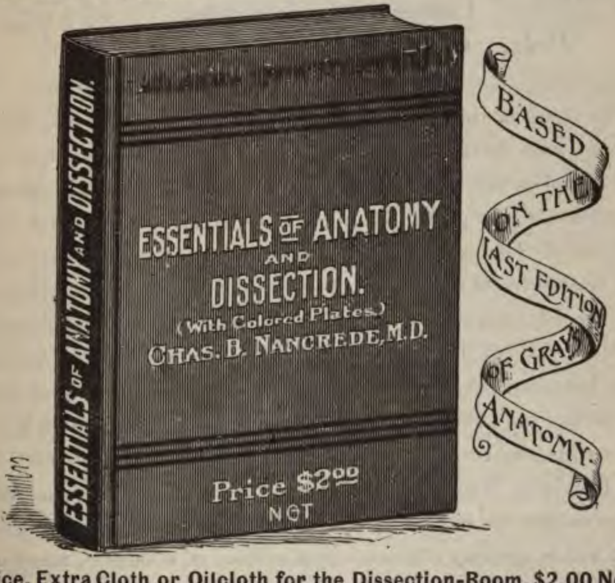
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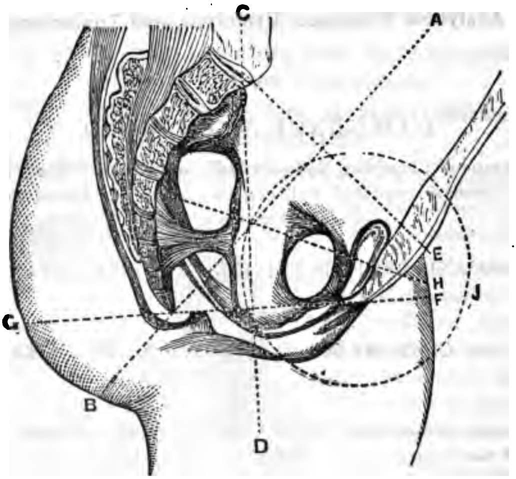

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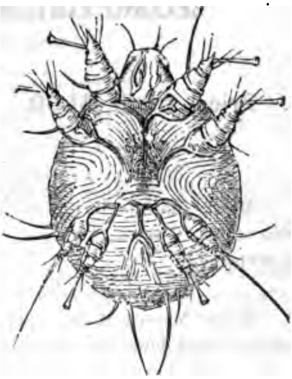

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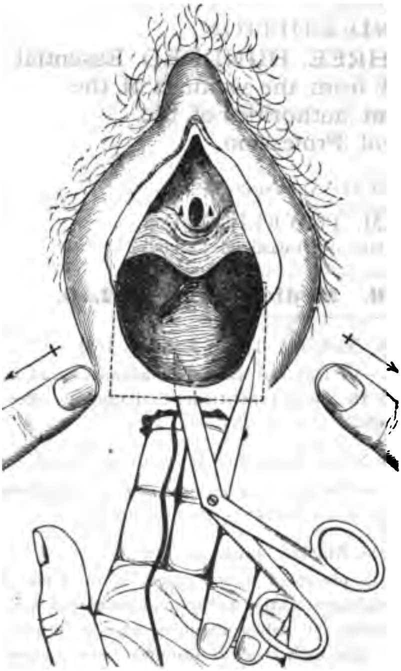

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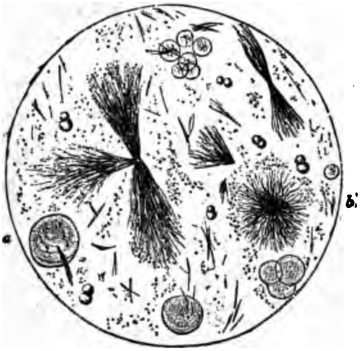

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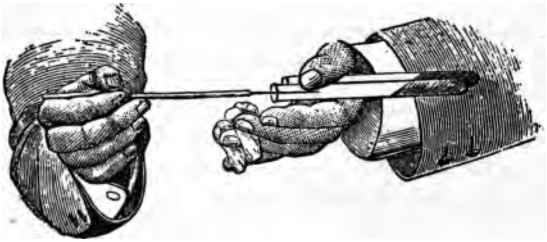

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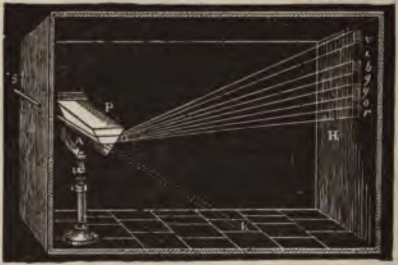

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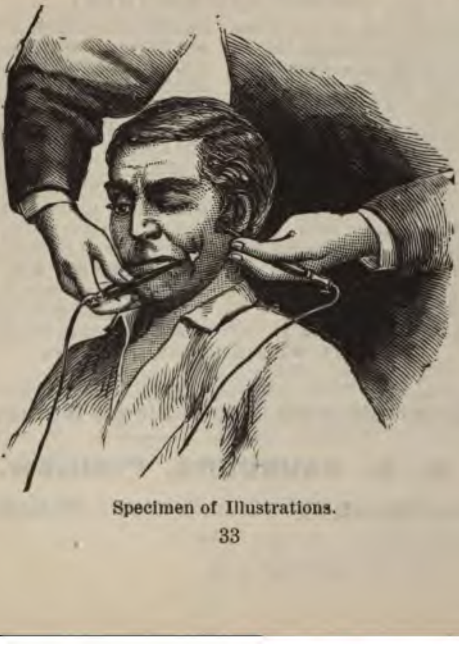

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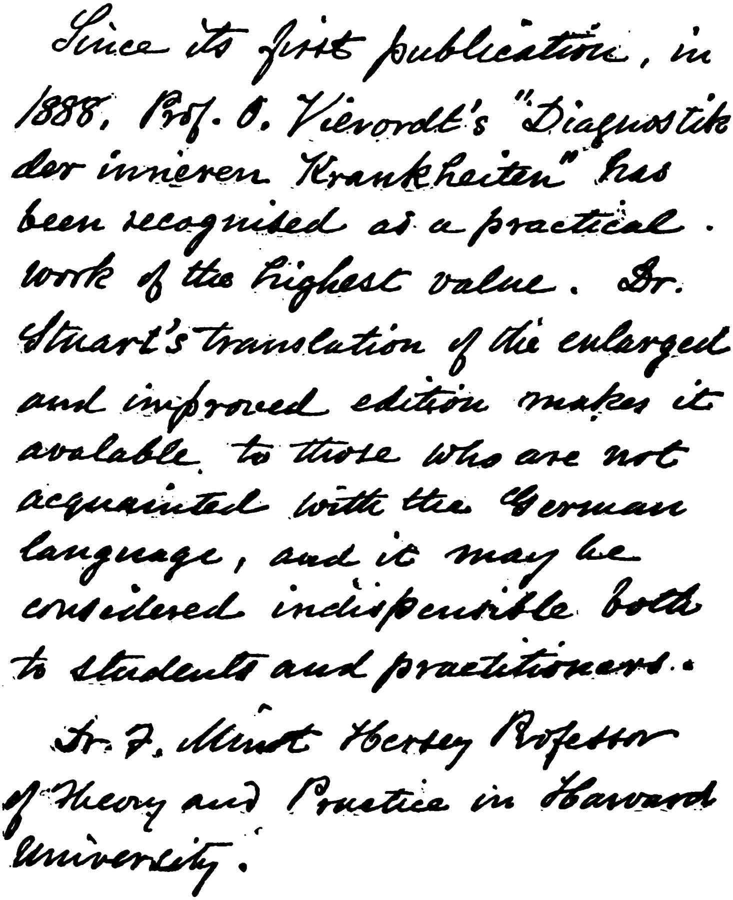

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